June 5, 1961

Aviation Week and Space Technology

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AVIATION CALENDAR

June 11-14—Summer Annual Meeting, American Society of Mechanical Engineers, Statler-Hilton Hotel, Los Angeles.

June 12-13—Third National Radio Frequency Interference Symposium, Institute of Radio Engineers, Sheraton Park Hotel, Washington, D. C.

June 13-15—37th Meeting, Aviation Distributors and Manufacturers Assn., Dennis Hotel, Atlantic City, N. J.

June 13-16—National Joint Meeting, Institute of the Aerospace Sciences and American Rocket Society, Ambassador Hotel, Los Angeles, Calif.

June 14-15—Fifth Annual Conference, Product Engineering and Production, Institute of Radio Engineers, Sheraton Hotel, Philadelphia, Pa.

June 14-16—Applied Mechanics Conference, American Society of Mechanical Engineers, Illinois Institute of Technology, Chicago.

June 18-23—Summer General Meeting, American Institute of Electrical Engineers, Cornell University, Ithaca, N. Y.

June 19-21—Space Flight and Re-entry Trajectories Symposium, International Astronautical Federation's International Academy of Astronautics, Paris, France.

June 19-21—Institute of Navigation—USAF Symposium on Supersonic Air Transport Navigation, Western Hills Hotel, Ft. Worth, Tex.

June 22-23—Eighth Annual Symposium on Computers and Data Processing, Denver Research Institute, Elkhorn Lodge, Estes Park, Colo.

June 24-27—First Reunion of World War I Overseas Flyers, Air Force Museum,

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AVIATION WEEK and Space Technology

June 5, 1961
Vol. 74, No. 23

Published weekly with an additional issue in December by McGraw-Hill Publishing Company, James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. **Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Printed at Albany N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

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Single copies 75¢. Subscription rates—United States and possessions, $7 one year. Canada $8 one year. All other countries, $20 one year.

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Second class postage paid at Albany 1, N. Y. Printed in U. S. A. Title registered in U. S. Patent Office.
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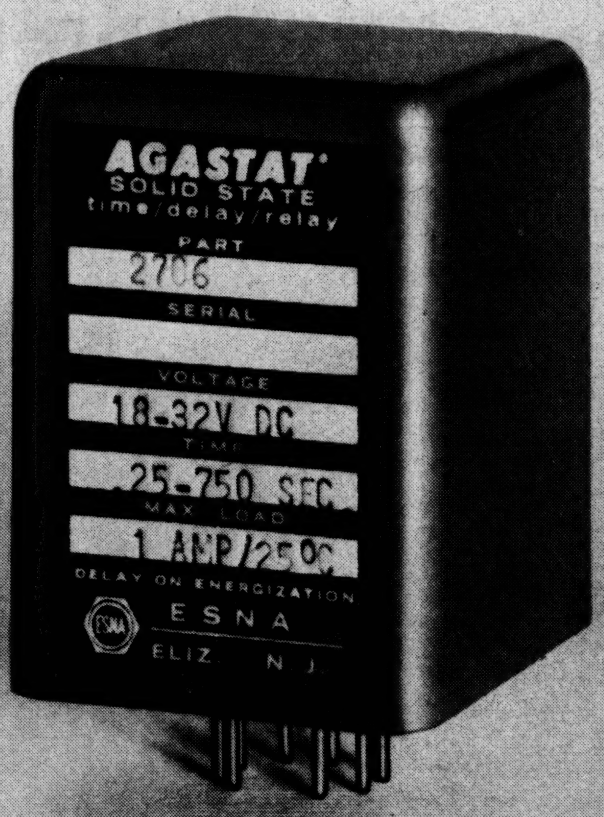

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AVIATION CALENDAR

(*Continued from page 5*)

Wright-Patterson AFB, Dayton, Ohio.

June 26-28—Fifth National Convention on Military Electronics, Institute of Radio Engineers, Shoreham Hotel, Washington.

June 26-28—European Symposium on Space Technology, British Interplanetary Society, London, England.

June 26-30—Special Technical Conference, American Institute of Electrical Engineers' Aerospace Transportation Committee, Benjamin Franklin Hotel, Philadelphia.

June 27-29—International Symposium on Analytical Astrodynamics, Santa Barbara, Calif. (Contact: Capt. J. L. Gilbert, Air Force Office of Scientific Research, Washington 25, D. C.)

June 28-30—Joint Automatic Control Conference, University of Colorado, Boulder.

June 28-July 1—Annual Meeting, Institute of Navigation, Williamsburg Inn, Williamsburg, Va.

July 8-12—15th Annual All-Woman Transcontinental Air Race, San Diego, Calif.-Atlantic City, N. J.

July 17—Air Force Contract Aviation Services Symposium, National Aeronautical Services Assn., Hotel Washington, Washington, D. C.

July 20-21—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Grove Park Inn, Asheville, N. C.

July 24-26—Air Traffic Control Facilities Symposium, Electronic Maintenance Engineering Assn., Mayflower Hotel, Washington, D. C.

July 25-Aug. 10—International Trade Fair and Aviation Exhibition, McCormick Place Exposition Center, Chicago, Ill.

Aug. 1-3—Fourth Western Regional Meeting, American Astronautical Society, Sheraton-Palace Hotel, San Francisco, Calif.

Aug. 7-9—Guidance and Navigation Conference, American Rocket Society, Stanford University, Palo Alto, Calif.

Aug. 15-17—Cryogenic Engineering Conference, University of Michigan, Ann Arbor.

Aug. 16-18—International Hypersonics Conference, American Rocket Society, Massachusetts Institute of Technology, Cambridge, Mass.

Aug. 19-24—Institute of the Aerospace Sciences/Naval Aviation Meeting, San Diego, Calif. (Classified.)

Aug. 22-25—Western Electronic Show and Convention, Cow Palace, San Francisco.

Aug. 24-26—Sixth Annual National Reunion, OX5 Club of America, Allis Hotel, Wichita, Kan.

Sept. 4-10—1961 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Sept. 4-14—Eighth Anglo-American Conference, Institute of the Aerospace Sciences, London, England.

Sept. 6-8—National Symposium on Space Electronics and Telemetry, Institute of Radio Engineers, University of New Mexico, Albuquerque, N. M.

Sept. 10-12—National Convention, National Aeronautic Assn., Westbury, N. Y.

Oct. 2-7—12th International Astronautical Congress, Washington, D. C.

Oct. 9-15—American Rocket Society's 16th Annual Meeting & Space Flight Report to the Nation, Coliseum, New York, N. Y.

June 5, 1961

Aviation Week and Space Technology

Vol. 74, No. 23
Member ABP and ABC

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COVER: Boeing 727 wing geometry and outboard powerplant nacelle, enclosing a Pratt & Whitney Aircraft J57 engine, are shown being flight-tested on the Boeing 707 prototype. Engine layout of the fifth powerplant provides a check of flow characteristics around the nacelle and inlet. Engine tailpipe is raised to elevate exhaust discharge above horizontal tail of the 707. Leading and trailing edges of wing have been modified (see p. 79 for details).

PICTURE CREDITS

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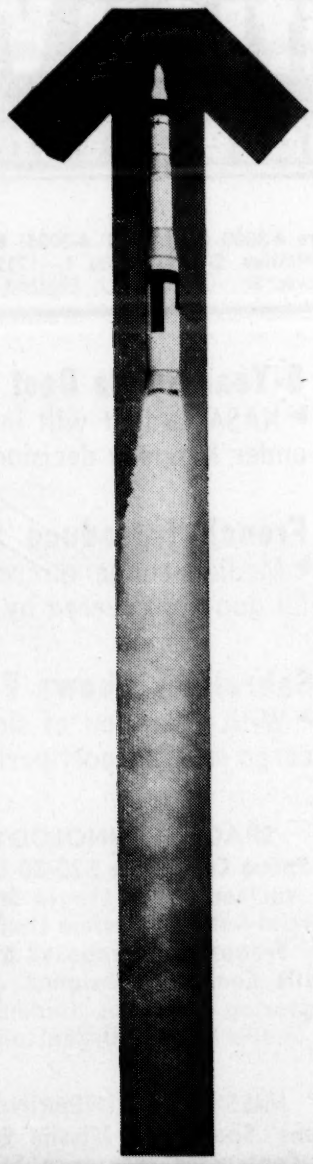

MINUTEMAN

In 1957, the Air Force Ballistic Missile Division, now the Ballistic Systems Division, awarded Space Technology Laboratories, Inc. a contract to study the feasibility of a solid propellant, multi-stage Intercontinental Ballistic Missile. When that study demonstrated that such a missile system was technically feasible, STL was awarded a contract to provide systems engineering and technical direction for the program to bring the system into being.

Design criteria for the system and its subsystems were prepared by STL as a member of the industry team which, under the leadership of the former Air Force Ballistic Missile Division, set about the task of creating the Minuteman system. Guided by the principle of concurrency and spurred on by the same appreciation of urgency which marked the development of those other Air Force weapon systems in which STL performed systems engineering and technical direction — Atlas, Thor and Titan — this industry team met the rigorous time schedule established for the program. The first captive test of the missile was made on 15 September 1959, the exact date scheduled eighteen months earlier. The dramatically successful first flight test at Cape Canaveral on 1 February 1961 occurred within weeks of the programmed date.

The Minutemen of STL are proud of their role in the development of the Minuteman system, and of their association in that program with: Boeing Airplane Co. (assembly and test); Autonetics Division of North American Aviation (guidance and control); Thiokol Chemical Corp., Aerojet General, and Hercules Powder Co. (propulsion); and Avco Corp. (re-entry vehicle).

Minuteman has passed its first research and development flight test. Ahead lies the work of completing the ground system and missile development, and of bringing the system to operational readiness. These tasks require qualified engineers and scientists to augment STL's Minuteman team in both Southern California and Cape Canaveral. Those capable of contributing to this important program in Space Technology Leadership are invited to write Dr. R. C. Potter, Manager of Professional Placement and Development, at either location.

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EDITORIAL

Resurgent French Industry

Convincing proof of the remarkable resurgence of the French aircraft industry is evident in the exhibitions and technical aura surrounding the 24th International Air Show at Le Bourget during the past week.

During the early 1950s the French aircraft industry had a hard time rising phoenix-like from the ashes of World War II to rebuild its technology and production facilities into the capability for competing successfully in the post-war supersonic era.

During these difficult years the French wisely committed relatively heavy investment in relation to their total resources to research and development, getting experimental prototypes into the air and retooling with the latest production methods.

While this phase was under way, the French also consolidated their numerous smaller companies into several solid teams, retaining both government-owned and private corporations to ensure the vitality of technical and commercial competition. It is interesting to note that the French made this significant consolidation some four years before the British aircraft industry faced a similar problem.

Now it is evident that this investment is paying substantial dividends in providing France with a technically modern aircraft and missile industry that can meet its varied military and civil requirements for French-flavored communities in Africa, Asia and Europe, can command a substantial share of the growing NATO market through joint design and production programs with other countries, and also is emerging as a strong competitor in international export markets.

One of the best yardsticks by which to measure the current French aviation industry is its success in the bitter competition for foreign markets. Last year about 42% of the industry's $440 million sales was accounted for in the export market. This year about half of all French industry aircraft and missile sales will be in foreign markets. The French have made a significant if relatively unpublicized penetration into the U.S. market with Turbomeca small gas turbines, Caravelle transports and Alouette helicopters. We can look forward to increasingly stiff competition from French turbine-powered executive transports in the near future.

Even more significant has been the success of the French industry in recent years in selling against stiff British competition in what were traditionally Commonwealth markets. For example, India bought supersonic Dassault Mystere IV fighters and recently picked the Breguet Alize anti-submarine warfare plane over the British Fairey Gannet and has also picked the Dassault Mirage III for its Mach 2-plus interceptor. In Australia the French bested the U.S. and British competition with their Mirage III for the Royal Australian Air Force and also sold the Snecma Atar 9 turbojet to power it in this traditionally British engine market. The Super Broussard bush plane is also likely to beat out its British and Canadian competition in Australia's relatively large market for this type aircraft. South Africa is giving the Mirage III strong consideration.

In the helicopter field more than 800 gas-turbine-powered Sud Aviation Alouettes have been sold in 20 countries while French lightplanes such as the Morane Saulnier jet-powered Paris and the piston-powered Rallye are selling well throughout Asia, Africa and Europe—about 350 Rallyes have been sold so far.

In the missile field, Nord Aviation is currently Europe's largest producer of missiles.

By the end of 1960 Nord had built 50,000 tactical and target missiles and its ramjet target missiles, anti-tank weapons and air-to-ground missiles are being sold abroad and are being built by foreign firms under license.

The French aviation industry has also been successful in getting its share of an increasing NATO market for aircraft and missiles. Starting with the earlier Nord Atlas transport and Fouga Magister trainer programs, the French have built up a substantial NATO market through cooperative programs with Germany, Italy, Great Britain and other participants in the alliance. Currently these include the Transall cargo transport being built by Nord with German assistance and British Tyne turboprops; the Breguet Atlantic anti-submarine warfare plane in which five NATO countries are involved, and Sud Aviation's Frelon helicopter program using technical aid from U.S., Italy and Germany.

In addition, the French are making strong bids for both NATO VTOL fighter and STOL transport requirements. The French have concentrated heavily on developing an early STOL transport capability based mainly on requirements for operations in the French-oriented sphere of newly-independent African nations but which also is appearing increasingly attractive for the export market in underdeveloped countries where air transport development is vital to overall economic improvement and where resources are not available for large-scale airport construction.

Perhaps the most controversial issue now facing French industry is whether it is necessary to develop an atomic striking force of Mirage IV bombers and IRBMs to buy France a seat in the international atomic weapons club and whether this financial and technical effort will strain the industry to the point where other promising developments may have to be abandoned. France also is determined to develop its own IRBM capability and participate with growing effort in space technology. Carrying all this load may prove difficult in view of the limited size of French research and production facilities, plus the increasing competition for skilled workers with other expanding industries such as automobiles, electronics and chemicals. The French have relied on technical interchange with the U.S., Britain and now Germany's forthcoming aerospace technology and are oriented to pushing hardest into gaps left by the major competitors in the over-all aerospace spectrum.

France can be justly proud of the position its aviation industry now occupies in the world and of its success in international markets. It will, however, take an effort even greater than that of the past decade to maintain this position in the aerospace world in the next decade where the excellence of each nation's technology and its application to its own particular problems will be more important than ever before.

—Robert Hotz

D DAY, THE LACK OF RECONNAISSANCE AND A FAULTY COMMAND DECISION

At 10:15 p.m., June 5, 1944, Lieutenant Colonel Meyer, counter-intelligence chief of the Fifteenth German Army burst into his commander's dining room, interrupting a relaxed game of cards. He held a message intercepted from Allied Headquarters, a message the German General Staff knew meant Allied invasion within 48 hours! But the card game placidly continued. Reason: no reconnaissance verification. Though a 5,000 ship, 20 mile wide invasion fleet clogged the English Channel, not a single Luftwaffe plane reported this progress. And so Field Marshal Rommel, commander of German forces in the area, was not notified until after H hour and remained on leave in Germany. Later, urgent pleas for panzer divisions in reserve near Paris were rejected by higher authority in Germany who thought the Normandy invasion was merely a diversion.

Why such confusion, particularly when Rommel's military tactics included the study of Confederate generals with their dependence on the swift reconnaissance "eyes" of J.E.B. Stuart's cavalry? Answer: unlike the reconnaissance-wise Confederates, Rommel's "eyes" were obsolete for their day... fighter aircraft, modified for the important reconnaissance mission. Result: lack of reconnaissance... D-Day success for the Allies.

From the beginnings of communities on the face of the earth, reconnaissance has helped shape history. Today CAI's specialty in this area is helping shape history to the advantage of the Free World. Typical of CAI contributions are: **V.I.P.** Visual Integrated Presentation, data display system; **KA-30** the world's most versatile aerial camera; **SOLO** the only electro-optical "available now" guidance system.

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WHO'S WHERE

In the Front Office

Joseph Kelley, Jr., president and general manager of Allied Research Associates, Inc., Boston, Mass., a subsidiary of The Boeing Co., succeeding **Lawrence Levy,** who has accepted a government post.

E. H. van der Beugel, president, KLM Royal Dutch Airlines, succeeding **I. A. Aler,** retiring. Mr. Aler has been appointed a director of KLM.

Senate Armed Services Committee has approved the nominations of: **John H. Rubel** as deputy director of defense research and engineering; **Paul R. Ignatius** as assistant secretary of the Army, (logistics and installations); **Dr. Brockway McMillan** as assistant secretary of the Air Force (research and development).

William E. Nelson, vice president and director of administration, Microdot, Inc., South Pasadena, Calif.

Harry E. Schauwecker, a vice president and director of engineering, U. S. Science Corp., Los Angeles, Calif.

Richard D. Lepman, a director, Chicago Aerial Industries, Inc., Barrington, Ill., replacing the late Ernest G. Loeb, who was president of the company. Mr. Lepman is associated with The Martin Co.'s Titan missile program.

James A. Reeves, executive vice president, Spacelabs, Inc., Van Nuys, Calif.

Harry E. Hjorth, vice president and managing director of Douglas Aircraft Company (Japan) Ltd., with offices in Tokyo, succeeding **Harold P. Leverenz,** who will return to Douglas, Santa Monica.

Dr. James B. Rea, vice president and assistant general manager-technical, Radioplane Division of Northrop Corp., Van Nuys, Calif.

R. V. Eldridge, secretary-treasurer, Pacific Scientific Corp. Bell Gardens, Calif.

Richard A. Campbell and **Dr. Ralph P. Johnson,** directors of Pacific Semiconductors, Inc., Lawndale, Calif., a subsidiary of Thompson Ramo Wooldridge, Inc. Mr. Campbell is executive vice president of PSI, and Dr. Johnson, vice president of the TRW Electronics Group.

Dr. Walter K. Volkers, president, director and chief executive of Lionel Electronic Laboratories, Brooklyn, N. Y.

Monroe R. Brown, vice president-administration, Piasecki Aircraft Corp., Philadelphia, Pa.

Honors and Elections

Scott Crossfield, director of space and missile systems test at North American Aviation's Space and Information Systems Division, has received the Aero Club of New England's annual Godfrey Lowell Cabot award for making the "most outstanding contribution to aviation" in 1960 for his X-15 flights.

Changes

Dr. Carl Clark, manager of life sciences, The Martin Co.'s Baltimore, Md., Division.

Donald W. Harris, small business liaison officer, Pratt & Whitney Aircraft Division of United Aircraft Corp., East Hartford, Conn.

INDUSTRY OBSERVER

► French army, still without a tactical missile, is now extremely interested in the Martin Pershing. The French five-year military program has earmarked $30 million for tactical missile procurement, and recent West German plans to buy Pershing have revived French interest in this field.

► **Navy is pushing Grumman to sell its A2F attack aircraft in Western Europe to increase production and cut over-all program costs. Best market prospect is West Germany, where the A2F would serve as an interim aircraft until NATO VTOL fighters become operational in the late 1960s.**

► Watch for the Spanish air force to get two squadrons of Lockheed F-104s equipped with Sidewinder missiles to bolster air defense of the Iberian peninsula. They probably will be bought with U. S. Mutual Defense Assistance Program funds. Spanish air force is now re-equipping transport squadrons with Douglas C-54s, but it is also seeking used Douglas DC-6Bs to provide increased airlift to handle logistics in Spain's African colonies.

► **Northrop still hopes to find a market for its N-156 lightweight supersonic development of the T-38 trainer as an interceptor and fighter-bomber, particularly in small countries with limited military budgets. In negotiations with USAF, Northrop offered a firm fixed unit price of $450,000 based on a minimum order of 650 aircraft.**

► Soviet satellite equipped with television cameras has been proposed by scientist N. Varvarov to photograph the entire surface of the moon from a circumlunar-polar orbit at an altitude of about 120 mi. It would take 308 of these 2 hr., 7.5 min. orbits to complete the mission, but if the satellite were equipped with small rockets to change the plane of each orbit, the job could be done in no more than 8 hr.

► **Navy plans to conduct the first full-scale test of its Hydra undersea launch system this summer off Pt. Mugu, Calif. Aerojet Algol, the solid propellant Scout first stage engine, will be used to boost a payload to an altitude of 70 mi. Test firings so far have been powered by just enough propellant to launch the vehicle a few feet above the surface.**

► Cdr. Alan B. Shepard has recommended a change in the location of a pressure gage in the Mercury capsule and modification of some of the voice communication procedures as a result of his Mercury-Redstone flight.

► **Seven NASA Nimbus advanced meteorological satellites are scheduled for development, five for orbital use and two for ground testing. Current budget includes approximately $5 million for development and construction and about $2 million for environmental testing.**

► Electrostatic tape subsystem has been removed from the Nimbus weather satellite because of development troubles. Main problem areas with the more advanced Aeros meteorological satellite have been identified so far as the variable focus television camera and reliable orbit adjusting system.

► **Second launch in the nuclear emulsion recovery vehicle (Nerv) program will be called Bios I. The payload will be flown in the fall and will contain a variety of biological specimens sensitive to various ranges of radiation, a cell fertilization experiment and an experiment to study micrometeorite flux and penetrability.**

► Tiros weather satellite East Coast data receiving station is being moved from Ft. Monmouth, N. J., to NASA's Wallops Island, Va., station to free the Army facility of the operating load. The RCA-operated readout station will be ready for the launch of Tiros III this summer, and it will be used for the four remaining Tiros experiments.

► **Use of nuclear fission effects to convert the more common chemicals into critical fuels, explosives, etc., will be studied under contracts soon to be awarded by Air Force. A key aim of the science of processing chemicals by fission, called fissiochemistry, is to lower the cost of currently expensive materials.**

SILICOLOGY

Studies in Silicones

HOW THESE TIME-TESTED MATERIALS CAN WORK FOR YOU

New Silicone Rubber Compounds Now Can Be Molded to Closest Tolerances

Looking for durable rubber compounds that offer precision molding, reliability, and flexibility over a wide temperature range—where other materials have failed?

Here is one example of how silicone rubber compounds came into existence to fill these requirements, through cooperation between Silicones Division engineers and their customers.

Sierra Engineering Company, Sierra Madre, Calif., had a new emergency oxygen mask under development for passengers on today's high-altitude, high-speed jet airliners. They needed a rubber material with these properties:

1. Resiliency to spring back to shape after folded storage.
2. Softness to conform to facial contours.
3. Extremely low oxygen permeability.
4. Good color dispersion.
5. Non-irritating, non-allergenic properties.
6. No smoke or fume problems during post-cure.

COOPERATIVE ENGINEERING

The Union Carbide Silicones Man brought these and other requirements back to his team of associates in R&D.

Prior to this, the combined technical and research facilities of Union Carbide Corporation, with tremendous resources of chemical experience and knowledge, had already achieved a long list of "firsts" in silicone rubber, including:

A controlled reactivity, vinyl-containing silicone rubber. A non-volatile catalyst system for one-step curing of thick sections. Electrically conductive silicone rubber. A rubber for electrical tapes, hot-air ducting, and other wrapped constructions. A compound to meet Naval cable specifications for atomic submarines. And the first and only silicone rubber compound qualified for automotive rear pinion seals.

FROM UNION CARBIDE—first commercial silicone compound for high-altitude emergency oxygen masks.

SIERRA ENGINEERING COMPANY of Sierra Madre, Calif., tests every silicone rubber mask it manufactures and maintains an accurate serial number check to be sure the quality is uniform at all times.

MEETING BASIC PRODUCTION PROBLEMS

For Sierra's oxygen masks, the principal properties needed had all been met before, *but not in a single silicone rubber compound.* Working closely with Sierra, engineers of the Silicones Division succeeded in formulating a compound that matched the needs and answered all basic production problems as well.

The new compound permits molding to extremely close tolerances. Its purity means freedom from smoke and fume problems during post-cure. It more than meets Sierra's strict quality controls, including complete performance test records on every mask produced. And the same compound is now also being used for Sierra's oxygen masks designed for military jet pilots and the crews of commercial planes.

MAIL COUPON FOR DATA

If your designing calls for rubber with advantages such as low temperature flexibility, thermal and oxidation stability at very high temperatures, low compression set, weather, ozone, oil resistance, electrical resistance or conductivity, your Silicones Man has them at his finger tips. The coupon below will bring your problems to his immediate attention.

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Washington Roundup

Space Impact Strategy

Strategy of the Kennedy Administration for gaining wide public acceptance of the great cost of space exploration (see p. 26) is becoming evident. It is to spread the effort —and therefore the involvement—as broadly as possible throughout the U.S. and to educate businessmen, universities, students and ordinary citizens to the importance and practical payoffs of a vast research program.

First concrete example of this was the first annual National Conference on the Peaceful Uses of Space, held recently at Tulsa, Okla. The key men behind it were National Aeronautics and Space Administrator James E. Webb, a former Oklahoma businessman; Sen. Robert Kerr of Oklahoma, chairman of the Senate space committee, and Harold Stuart of Tulsa, former USAF assistant secretary.

Although Kerr and Stuart were disappointed in the turnout of businessmen, the conference set the pattern for future "road shows" and generated a competition for location of next year's event. Sen. Warren Magnuson, a member of the Senate space and appropriations committees, wants it held in Seattle, Wash., in the second week of May. Stuart wants it returned to Tulsa.

Kerr put the space race in terms any Oklahoman could appreciate by saying it will take an average of 17,000 barrels of crude oil to produce the kerosene burned by the first stage of a single Saturn booster, and he pointed to the number of business and university space contracts in the state.

President Kennedy sent the conference a message calling space research and exploration "the very heart of our national policy" and predicting "a far-ranging effect within industry and in our labor force, on medical research, education and many other areas of national concern." He said he hoped the conference would "establish a precedent as the people of America move forward in space."

Forecasting Costs

Congressional demands for long-range defense planning—most of them aimed at forecasting costs—are increasing. Bills have been introduced that would direct the Secretary of Commerce to study the economic impact of defense and authorize a new congressional committee to watch this area. Defense Secretary Robert McNamara already has testified that he hopes to tag the cost of weapon systems five years into the future.

Second flight of a U.S. astronaut now appears to be off until mid-July, about the time NASA calls in prospective Apollo bidders. Second flight was set for the week of June 25, then for the week of July 2, now has slipped to the week of July 16.

Three-man commission that recommended a merger of the Air Line Pilots Assn. and the Flight Engineers International Assn. may be forced to reconvene and issue more explicit and detailed recommendations. Contract negotiations between airlines and FEIA had bogged down pending the commission's report. They may remain at a stalemate because FEIA says the findings "just put us back where we started." Cooperation between the two unions in adopting the findings within 30 days now appears unlikely.

Commerce Department's plans for an Office of International Travel, which is supposed to increase tourist traffic to the U.S. by 20%, are getting the finishing touches. They now call for both hard and soft sells, with six roving salesmen and well-manned tourist offices in London, Paris, Frankfurt, Caracas, Tokyo and an unnamed city in Australia. Road maps and brochures alone would require $650,000—almost four times the entire present tourist-attraction budget of $165,000.

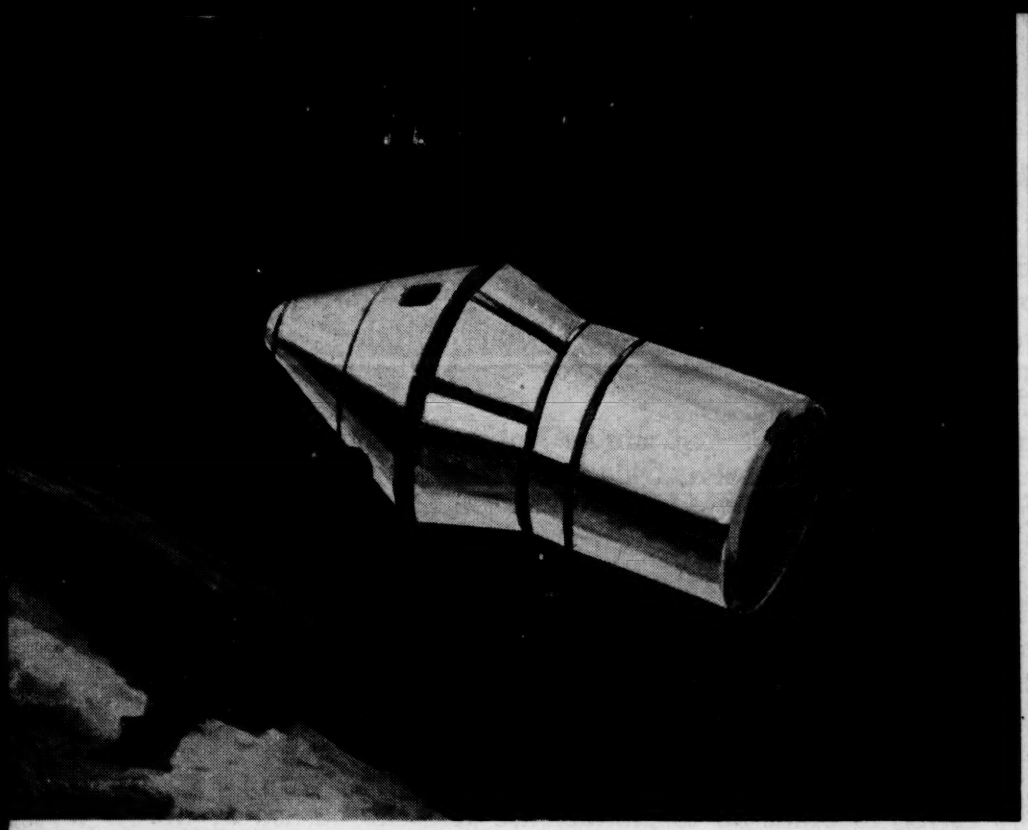
Commerce wants almost $3 million for the task, and President Kennedy is expected to push hard for this promotion effort in the belief that more tourists will improve both the balance of payments situation and international relations.

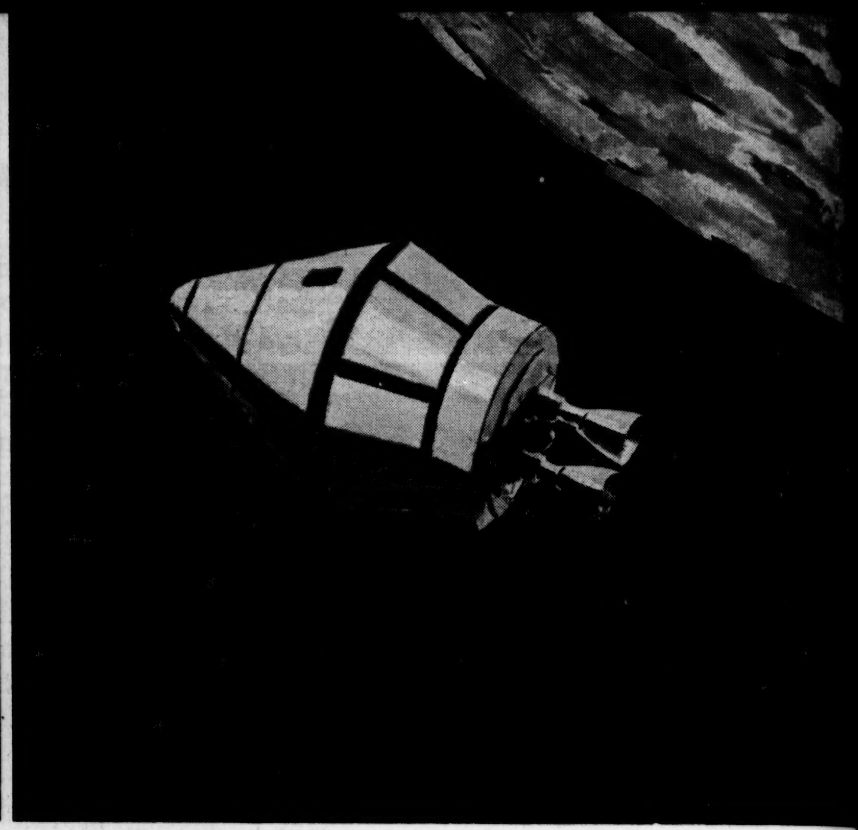
McClellan Strike Ban

Sen. John L. McClellan has prepared a stiff bill "to prohibit" strikes and walkouts at missile installations. He would like to have legislation poised over the heads of contractors and unions in case the no-strike pledges exacted by the Kennedy Administration are not fulfilled.

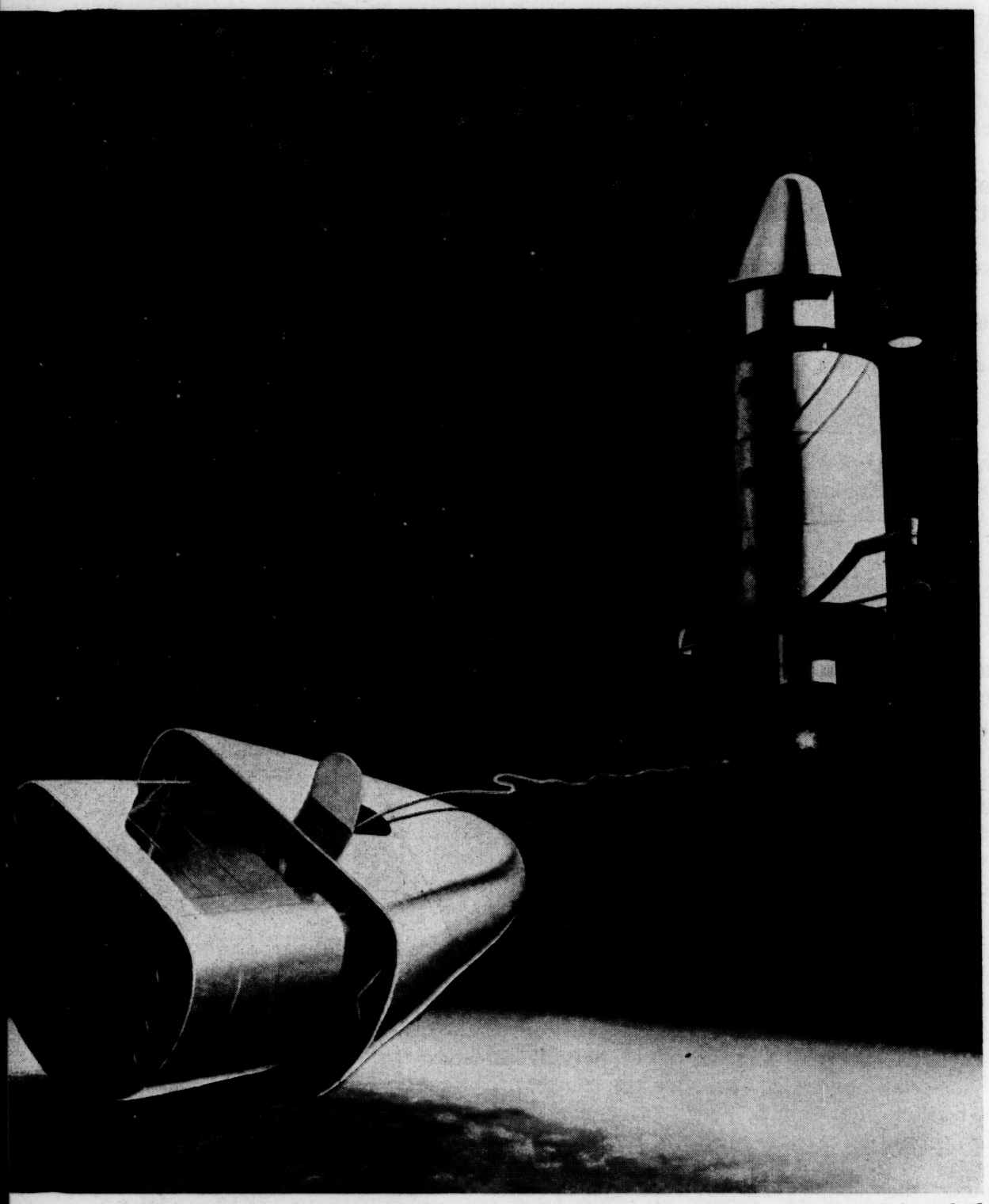
Sen. McClellan told Aviation Week he will introduce the bill—already drafted by his staff—before Congress adjourns for the summer. Although prospects for its passage are dim, further labor trouble would brighten them considerably, so even the proposed legislation should serve as an incentive for peace at the missile bases.

Among the taboo words for Pentagon speeches and press releases these days is "war." Even the "cold war" must be called a "political and technological struggle." A general recently submitted a release in which he referred to the X-15 as the "Man O' War of the research aircraft stable." Security reviewers returned the proposed release with the suggestion that he call the aircraft "the Seabiscuit" or "the Citation" of the research stable instead. **—Washington Staff**





BASIC Apollo module, as conceived by NASA, will be essentially identical for earth-orbiting, circumlunar and manned lunar landing missions.



MARTIN CO. drawing of manned space orbiting laboratory (MSOL) shows earth-launched vehicle sending out a line with an infrared sensor to rendezvous with a permanently-orbiting station. Re-entry body probably resembles Martin's Apollo concept, since Martin says it is adaptable to earth and circumlunar orbits and can be fitted for a lunar landing. Similar re-entry body is located on top of the laboratory, which is Martin's Aries concept.

SpaceProgram

By Edward H. Kolcum

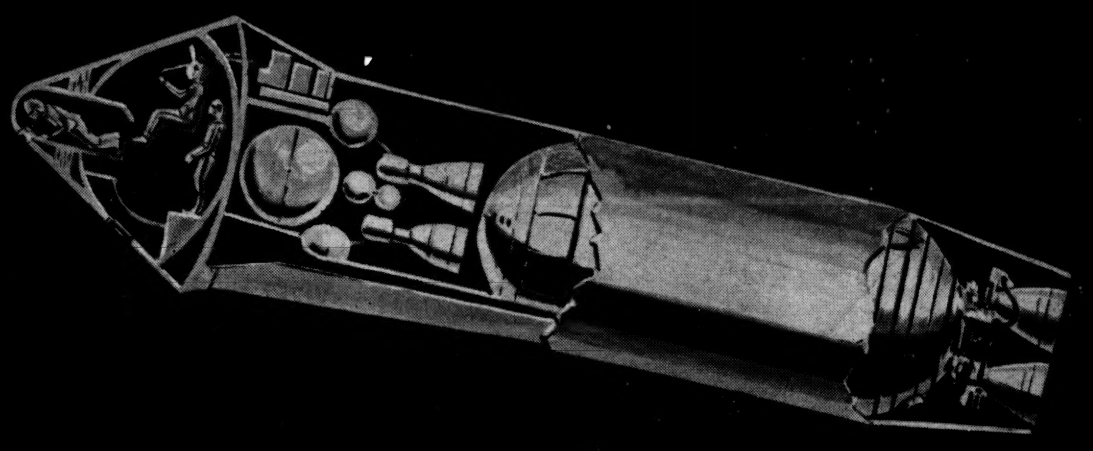
Washington—Total national space program over the next five years will cost $25-30 billion, and the civilian space budget will reach a $4-5 billion annual level by Fiscal 1963 under the current Kennedy Administration plan.

The Administration already had planned to spend an estimated $15-20 billion in the next five years but had not revealed the figure. The impact of the flights of Maj. Yuri Gagarin and Cdr. Alan B. Shepard, Jr., contributed to a White House decision to make a massive space effort that will raise both the spending level and the National Aeronautics and Space Administration's percentage of the total.

Both the White House and NASA will underscore the position that the U. S. has a good chance to be first with a manned lunar landing in their effort to push the agency's Fiscal 1962 authorization request through Congress. The request of $1,784,300,000 (AW May 29, p. 25) will be made with a cautionary note to Congress that it is probably the last civilian program to cost under $3-4 billion annually.

New National Goals

NASA Administrator James E. Webb estimated the new five-year program cost, and he characterized the Administration's actions in accelerating the space effort as the establishment of major new national goals, essentially in the areas of manned lunar landing, Rover nuclear rocket development, communications and weather satellites. However, all but nine of NASA's 24 research programs have received additional funds under the Kennedy request, and the White House action actually reflects relatively com-



ons. ossible configurations are all semi-ballistic shapes. Decision has been made to concentrate on parachute recovery.

m Will Cost $25-30 Billion Over Five Years

plete acceptance of everything the agency asked.

Pressure will be on NASA to produce scientific and publicity firsts leading to the manned lunar landing mission, but it is apparent that Webb and Vice President Lyndon Johnson have obtained general acceptance of the appropriation request in Congress.

Webb said he has "informed the responsible leaders of Congress, with whom I have to deal, as to how we were proceeding," and the Vice President has met with Senate and House space committees.

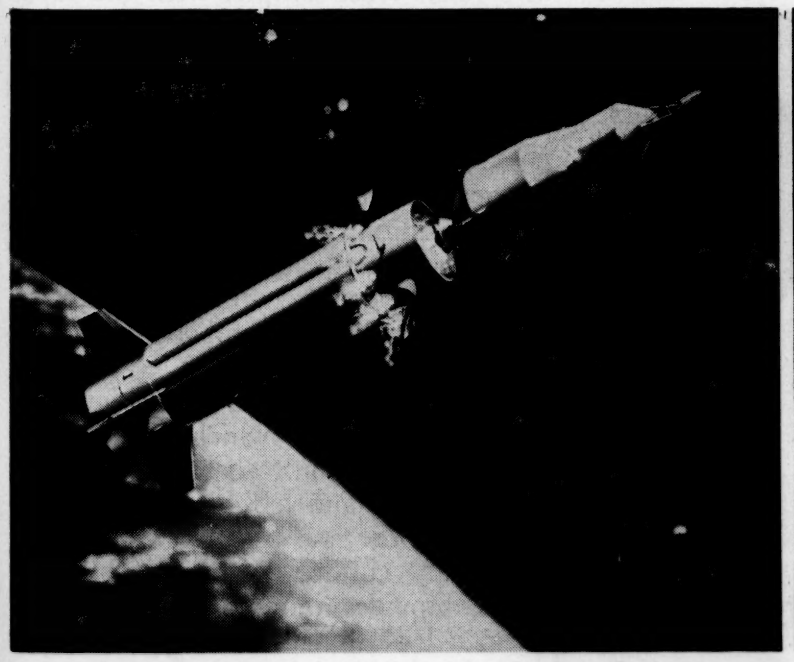
New Harmony

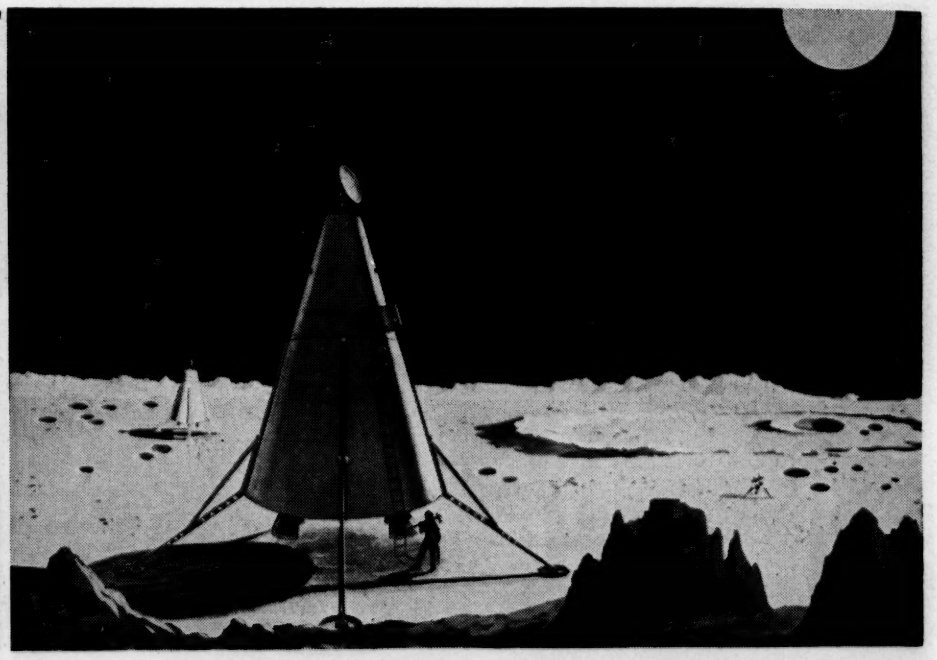
New harmony exists between NASA and the various Congressional committees which was missing when the agency was headed by Keith Glennan. In House appropriation hearings last month, Rep. Albert Thomas (D.-Tex.), chairman of the independent offices subcommittee, was highly complimentary of Webb and the civilian space program Webb outlined.

Breakdown of funds under the new Kennedy Administration recommendations shows significant increases for:

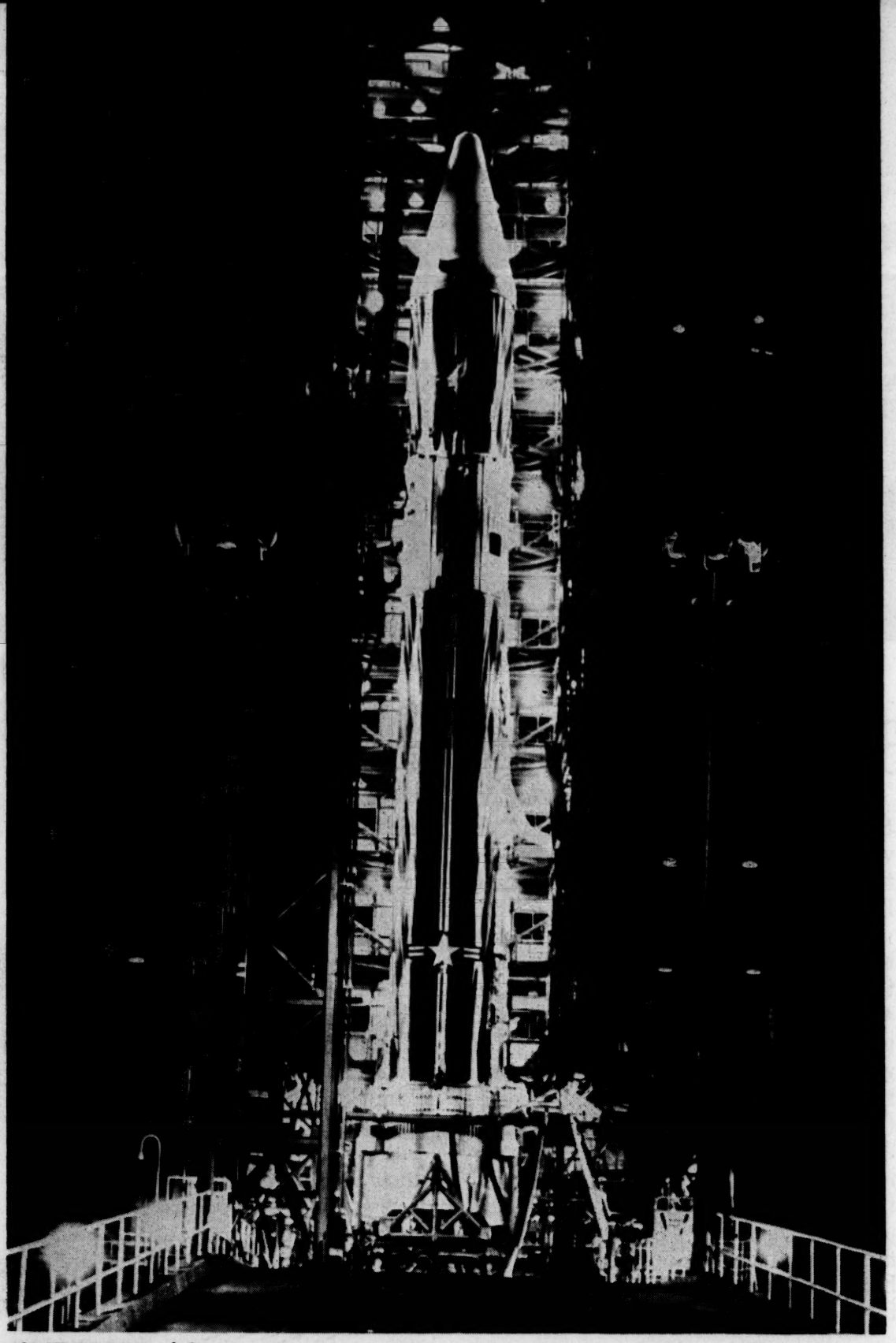
• **Apollo,** from $29.5 million to $160 million for research, meaning NASA will award one or more hardware contracts this fall instead of next January (AW May 22, p. 24). Prospective bidders will be briefed and specifications issued in mid-July. NASA has added the lunar landing mission to the Apollo program, and may establish a 1967 target date for manned lunar landing. Early program provided $24.4 million for incremental funding of launch vehicles and spacecraft development, and $5.1 million for advanced technical development in spacecraft and component design and evaluation. The added money accelerates hardware contracting, test flight program, development of the critical spacecraft propulsion system, and long lead-time funding for launch vehicles.

• **Weather satellites,** from $28.2 million to $50.2 million, permitting launch of four additional Tiros satellites, two more than had been planned. Two will contain infrared sensors. The program follows the plan of the National Coordinating Committee for Aviation Meteorology (AW Nov. 27, p. 27) which calls for a Tiros to be orbiting at all times until Nimbus is ready for launch, probably late next year. Five Nimbus payloads will be launched at six-month intervals, and two Aeros weather satellites will be launched in 1964. Weather Bureau will receive $175 million over the next three years, including $53 million in Fiscal 1962, to construct readout stations for Nimbus

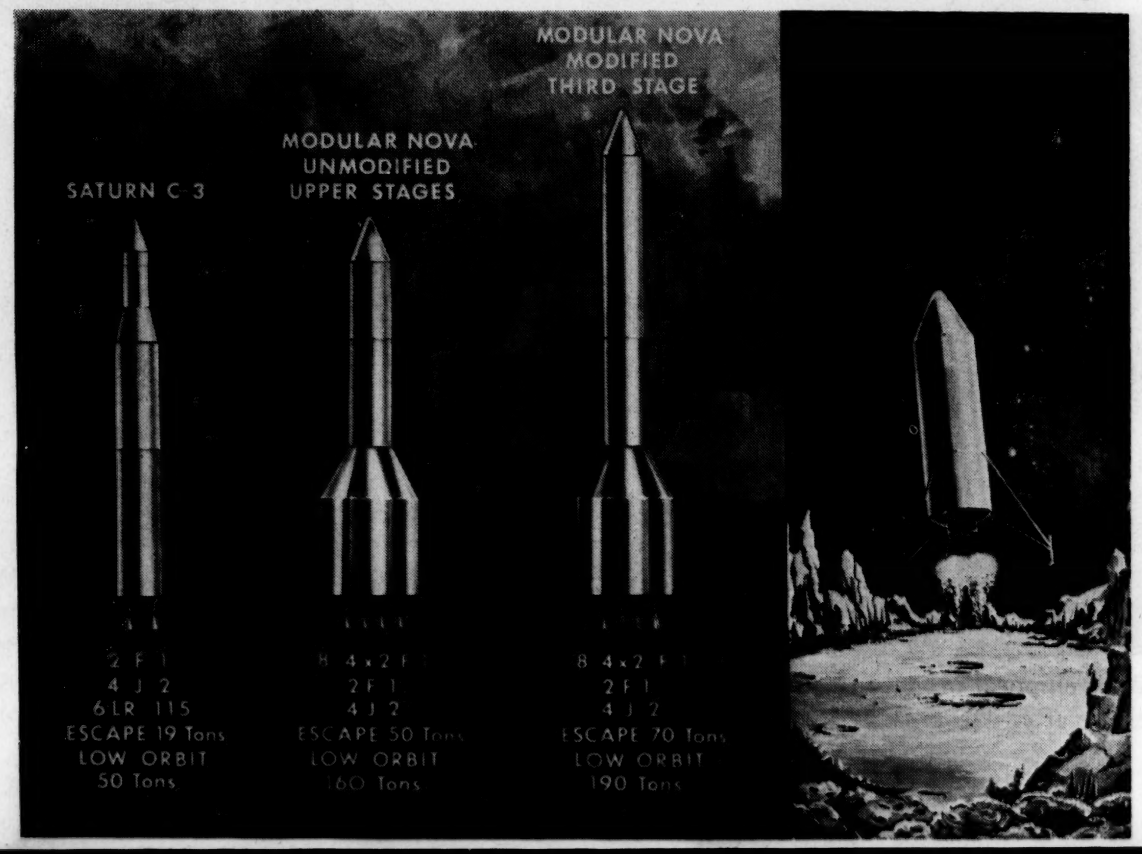




FIN-STABILIZED Saturn C-1 boosts Apollo into an elliptical orbit in this NASA conception. Vertical and horizontal takeoff attitudes are being considered for the Apollo lunar landing vehicle after it completes its lunar mission.



FIRST PHOTO of Centaur upper stage (above), shown during mating test with Atlas booster 104D at Cape Canaveral Pad 36A. Modular Nova concepts below show growth from Saturn C-3. Vehicle at right would contain third stage with increased thrust rating which could carry Apollo spacecraft and 20 tons of equipment.



in Fairbanks, Alaska; Blossom Point, Md., and Alert, Canada.

• **Life sciences,** from $8.62 million to $20.62 million, representing a solid victory for NASA in pursuing a flight program in bioastronautics (AW May 15, p. 34). Earlier funds were insufficient to conduct a serious five-part flight program planned with the Nerv flight package, long-term earth-orbiting recoverable satellites, balloon flights from Bemidji, Minn. and Fort Churchill, Canada, helicopter-balloon infrared experiments, and X-15 tests.

• **NASA research,** from $74.3 million to $89.1 million. This will allow NASA'S own laboratories to accelerate and provide plant support for work in re-entry, guidance, structural dynamics. life support systems, materials, the supersonic transport, military aircraft and advanced technology in weather and communications satellites and hydrogen-oxygen pumping systems.

• **Satellites and sounding rockets,** from $71.7 million to $81.7 million. The increase is designed to advance the polar-orbiting geophysical observatory a year to 1963, accelerate the observatory satellite program by providing backups to allow solar, astronomical and geophysical observatories to be orbiting continuously, and provide money to advance spacecraft development, which was admittedly thin. The $2 million added to the rocket budget will permit NASA to increase support of university sounding rocket tests.

• **Lunar and planetary exploration,** from $103.9 million to $159.9 million. This increase is tied directly to the Apollo manned lunar landing mission to accelerate basic studies of the lunar environment. Primary mission of the Prospector program has been reoriented to fit Apollo in that it will be a logistics vehicle to truck heavy equipment to the moon for a manned base. Prospector originally was designed as a mobile survey vehicle, and later seen as a lunar crust sampler with the capability to return samples to earth. These missions are still part of the program, but the major mission is to carry equipment such as jeeps and radiation shelters to the moon.

• **Communications satellites,** from $44.6 million to $94.6 million, explained as funds required to include government requirements in the ultimate system which will be commercially operated.

• **Nova and F-1,** from $42.3 million to $163.8 million, which may represent a firm decision to base the manned lunar landing launch vehicle on the F-1 engine. There was no Nova program until the current Kennedy budget, which provides money to start work on an F-1 cluster, plus funds for single and clustered engine test stands. In a reversal of an Eisenhower Adminis-

tration decision to assign all super boosters to NASA, the new budget allots $62 million to the Defense Department to develop a large solid rocket to NASA specifications, and $15 million to adapt the Titan II vehicle for space missions. NASA has been only lukewarm concerning large solids, despite congressional agitation to increase research in this area. Titan II space vehicle launcher is expected to be the standard two-stage missile plus an Agena B third stage. This vehicle, according to Deputy NASA Administrator Dr. Hugh L. Dryden, would back up "many elements of our program."

He said that there are some problems arising as to the capacity of Centaur and the weight of Advent, the Army's 24-hr. active communications satellite, "so that we want some assurance in this program by starting a vehicle based on Titan II."

Rover program increase (AW May 22, p. 30) provides $36 million for research, which NASA hopes will lead to a flight demonstration nuclear rocket by 1965, and $15 million for a test stand.

Congress Is Expected to Support Kennedy's Space Race Program

By George C. Wilson

Washington—Congress, with some misgivings, is expected to follow President Kennedy's lead and plunge the nation all the way into the space race with Russia.

Reaction to the President's second State of the Union message May 25, as well as the voting so far on space and defense legislation in Congress, indicates he will get pretty much what he asked in these fields. Less certain is the fate of Presidential requests for more money for foreign aid and civil defense (AW May 29, p. 25).

The President requested a space program which would cost $7-9 billion more over the next five years than the $15-20 billion which the Administration already had projected for that period (see p. 26). He asked Congress to increase the budget of the National Aeronautics and Space Administration in Fiscal 1962 from the $1,235,300,000 he requested in March to $1,784,300,000. The biggest single increase requested in the Fiscal 1962 budget for research was $130.5 million for the Apollo project to land a man on the moon.

Chairman Clarence Cannon (D.-Mo.) of the House Appropriations Committee, the man in the best position to trim the President's money requests, said he himself doubted it was worth spending millions of dollars to get to the moon. But he added it was certain Congress would vote the money requested.

Rep. Cannon told AVIATION WEEK the President's space requests are "wholly unrealistic and fantastic beyond measure" and the implementation of them on the crash basis recommended would cause "vast waste."

"To defend this nation . . . as a matter of fact for survival," Rep. Cannon said, "we have just so much money; so much technical resources; so much strategic material, and above all so much time. And from this we must apportion our resources to those objects where they will accomplish the most . . . the purpose for which they are spent must be practical." He said spending millions for space is spending money on something "purely conjectural. Any advantages to be secured are problematical. There is no assurance we will have any return."

But other Democratic leaders in Congress took what appears to be the majority viewpoint by declaring the U.S. cannot afford to be second in space and therefore must spend whatever is necessary. Chairman Robert S. Kerr of the Senate Aeronautical and Space Sciences Committee said the President in his speech "pushed the button on a booming new space age . . . the cost will be tremendous but the resources are unlimited." Predicting Congress will respond favorably to the money requests, Sen. Kerr said: "Indeed, there can be no price tag on survival in this dangerous world."

Chairman Overton Brooks (D.-La.) of the House Science and Astronautics Committee hailed the President's space program "as a tremendous stride forward." His committee last month authorized more money for space programs than the President previously had requested (AW May 8, p. 27).

Among Republicans, reaction was mixed. House Minority Leader Charles A. Halleck (R.-Ind.) said the space requests are part of a Kennedy Administration "jungle of unprecedented spending and loose fiscal policy" while Chairman Styles Bridges (R.-N. H.) of the Senate Republican Policy Committee said the President's space objectives "are sound" and "I shall support him." The Democrats enjoy heavy majorities in both the House (262-174) and Senate (65-35) and therefore can overcome the opposition of the Republicans who share Rep. Halleck's view on the President's requests.

The widespread support in Congress for increased space and defense spending manifested itself in recent floor votes. The House by voice vote passed the space committee bill authorizing more money for NASA than the President requested, while both the House and Senate added money to the bill authorizing aircraft and missile procurement (AW May 29, p. 28).

With foreign aid and civil defense, the prospects are that Congress will not go as far as the President requested. Chairman H. William Fulbright (D.-Ark.) of the Senate Foreign Relations Committee said it would be "very difficult" to get Congress to vote more foreign aid money, including military aid, than was already requested.

The President's request for some $300 million for civil defense shelters in Fiscal 1962 is not expected to be granted because of competing demands for federal funds. Mr. Kennedy said the shelter program would cost "more than triple" the $104 million in the Fiscal 1962 budget for all civil defense programs and "will increase sharply in subsequent years."

X-15 Flies Without Stability Augmentation

Edwards AFB, Calif.—Stability augmentation system of the NASA-North American X-15 failed at engine ignition in the speed record-breaking flight, May 25, but test pilot Joe Walker reported no serious difficulty in controlling the airplane.

The system failed in both pitch and roll modes of operation. Walker was able to reset the roll mode, but there was no stability augmentation in pitch for the remainder of the flight. Normally, the stability augmentation system is an integral link in the X-15 control loop but the pilot can override it and the controls can function without it. Walker said it "only needed a little more muscle."

The objective of the high speed test was Mach 5.1, but the high range stations between Wendover, Utah and Edwards reported that top speed was Mach 4.9. The high range station reports lowered all the early performance estimates published immediately after the flight. Maximum speed was 3,307 mph. at an altitude of 82,890 ft. rather than 3,370 mph. at 90,000 ft. Apogee was 107,500 ft. rather than 110,000 ft. Maximum temperature was 680F rather than 700F.

Burning time of the Reaction Motors' LR-99 engine was 73 sec. at 100% power. Duration of the flight was 13 min.

AERIAL VIEW of Paris static display shows the pavilions of the exhibitors in the foreground, aircraft on display in the center and, in the background, the ramp of Le Bourget Airport handling regular commercial traffic. Building at right is the main exhibition hall.

V/STOL Proposals Dominate Paris Show

By Cecil Brownlow

Paris—VTOL designs, proposals and politics were dominating factors at this year's Paris International Air Show at Le Bourget Airport.

The show had only one flying VTOL test vehicle on hand, the Short SC. 1, but the static displays and technical conversation at the exhibits emphasized Europe's growing interest in a family of V/STOL aircraft.

Companies in France, Germany, Great Britain, Italy and The Netherlands already are drafting proposals to meet current North Atlantic Treaty Organization requirements for a close-support V/STOL fighter capable of a flying distance of 250 mi. on-deck at minimum specified speed of Mach .92, and equipment similar to that to be offered to NATO was on display here.

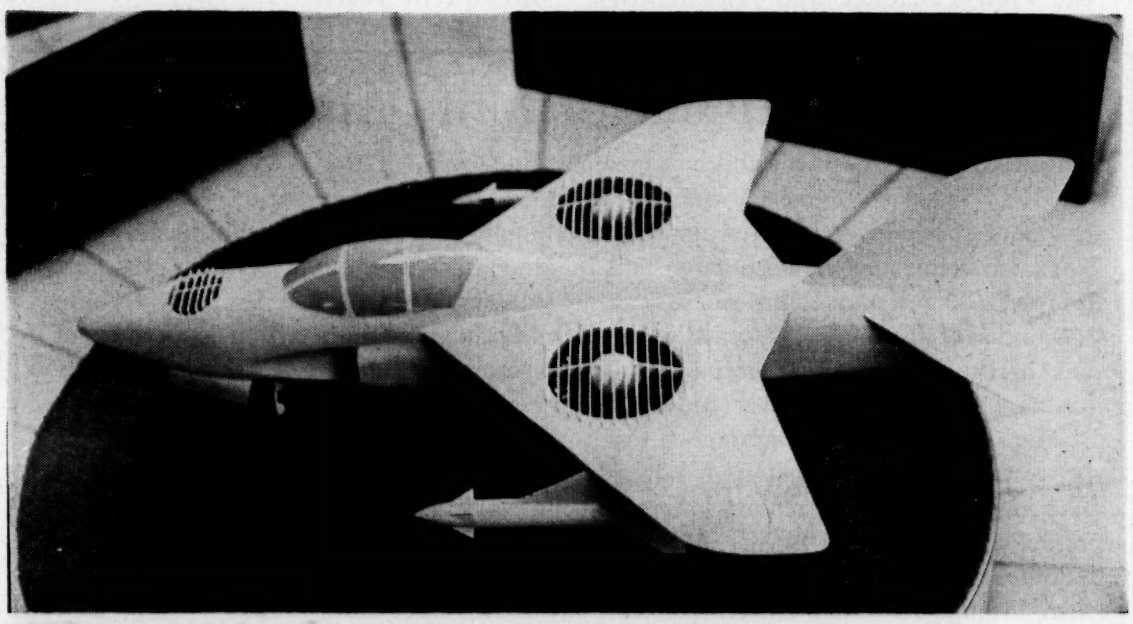
England's Bristol Siddeley exhibited its BS.53, predecessor to the larger, 30,000-lb.-thrust-plus BS.100 now under development as the powerplant for a joint Republic-Fokker proposal for a variable wing, all-weather fighter design capable of sustained on-deck speeds of above Mach 1.25. Powerplant also may be incorporated into a follow-on program to the BS.53-powered Hawker P. 1127 in which Germany and Britain are cooperating.

Rolls-Royce exhibited an engineering mockup of its RB.145 lightweight, 2,750-lb.-thrust turbojet that probably will be used as an interim powerplant on a German V/STOL transport under design by Focke-Wulf until the emergence of the RB.162 on which Germany, France and Britain signed a joint development pact just before the opening of the show.

Like the BS.53 and BS.100, the RB.145 can be used to provide both vertical lift and power for horizontal flight as does the RB.153 which is scheduled to go into a close-support fighter being developed by the German consortium of Messerschmitt, Heinkel and Bolkow under government sponsorship.

Rolls, however, is maintaining its philosophy of separate powerplants for lift and horizontal flight, concentrating upon low cost, light weight and ease of maintenance. An RB.145 predecessor, the 2,010-lb.-thrust RB.108 used in the Short SC. 1, provides lift only and so will the much advanced RB.162. Rolls also is making substantial progress in improving the thrust-to-weight ratio in its VTOL designs. The 108 has a ratio of 8:1, and the 145's is only slightly better. But the RB.162 is scheduled to attain a ratio of 16:1.

As a third approach, General Electric's display included models demonstrating the company's lift-fan proposal for Mach .92, close-support aircraft under development for the U.S. Army which GE also would like to market in Europe, either as a package or in the form of technical assistance to a going project. Power for both lift and horizontal flight is provided by two GE J85 turbojets of 2,500-lb.-thrust



GENERAL ELECTRIC CO. model demonstrates the company's lift-fan VTOL principle under development for the U. S. Army. Two J85 turbojet engines housed in the fuselage provide power for both vertical lift and horizontal flight.

USAF CONVAIR B-58 supersonic bomber which set a new nonstop transatlantic speed record in a flight from Carswell AFB, Tex., to Le Bourget Airport, as a highlight of the 24th international air show, draws the crowd from the giant Soviet Tu-114 turboprop transport during the exhibition's static display. B-58, piloted by Maj. William Payne, covered the distance between Carswell and Le Bourget in a total elapsed time of 6 hr. 15 min., flying the New York-Paris leg in 3 hr. 19 min., 41 sec. Aircraft was refueled twice from a Boeing KC-135 during the flight, at a point just northeast of Newfoundland and again off the coast of France and flew 1 hr. 49 min. at Mach 2. Tu-114 displayed new Aeroflot color scheme. Upper portion of the fuselage is painted white with blue striped trimming.

each housed conventionally in the fuselage. For lift, power from the J85s is diverted to a large lift fan in either wing and to a smaller control fan housed in the nose section. As altitude is gained, a series of louvers gradually diverts the thrust back to a straight line and horizontal flight is begun.

Focke-Wulf exhibit included a model of a wingtip pod housing three small lift engines similar to the RB.162 in the forward section of the pod and three in the rear section that will be incorporated into its V/STOL transport design. Panels located on top and bottom of the pod spring outward to expose engines during ascent and descent and then close to provide a streamlined shape for horizontal flight.

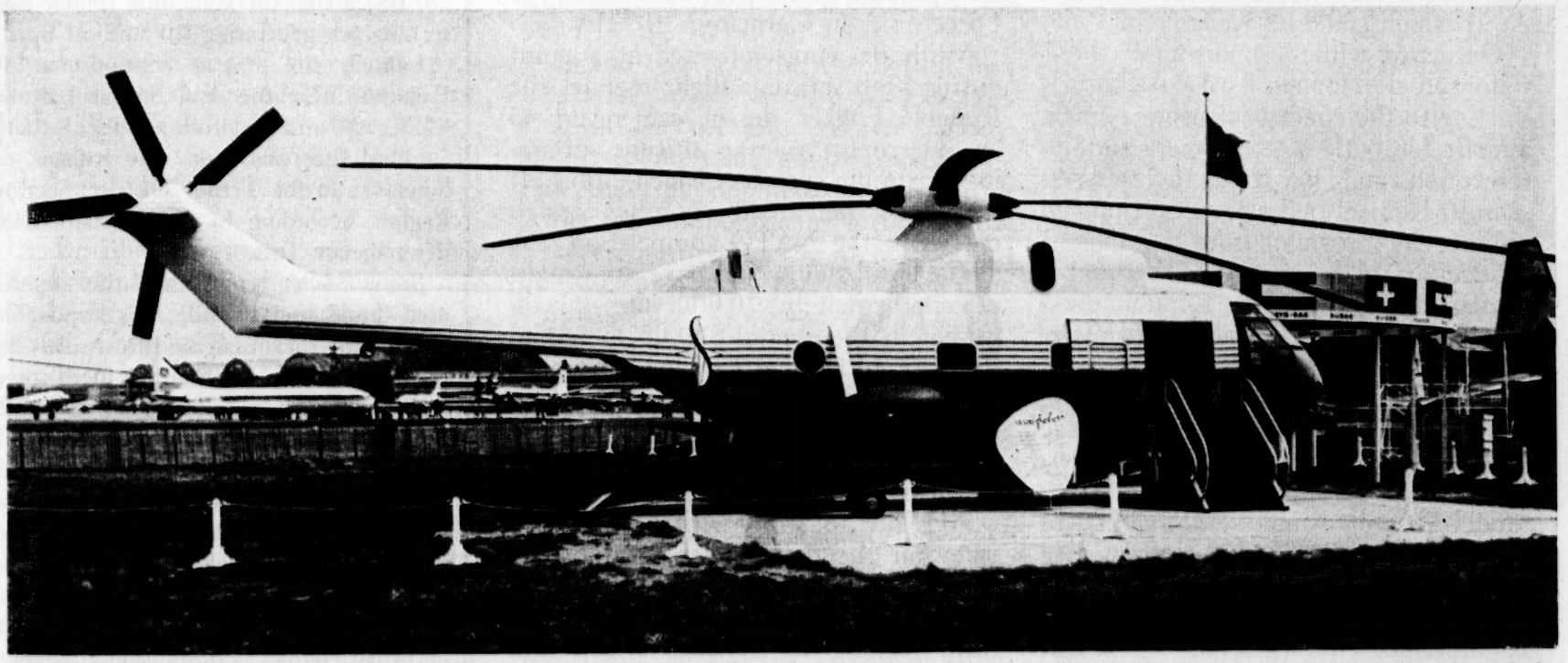
German Design

German Defense Ministry, which is pushing a V/STOL transport design primarily to support the dispersed sites for its planned V/STOL fighter units, gave Focke-Wulf and associated firms a go-ahead on the project in late May. Dornier also has been working in Germany on a V/STOL transport design.

Fiat's display featured a schematic of the engine arrangement of its entry into the NATO close-support competition, G. 95 follow-on version of the G. 91 (AW May 22, p. 75).

Schematic showed a total of four lift engines housed in the fuselage, two located forward and two situated aft, plus two main powerplants also housed in the fuselage.

Aside from the various, and apparently frangible, political agreements for joint VTOL development projects to meet current and anticipated NATO requirements, the major issue centers



FULL-SCALE MOCKUP of the Sud 3210 Frelon heavy helicopter, successor to the Frelon 3200 prototype now undergoing flight test trials, can carry a total of 27 troops at a maximum gross weight of 24,250 lb. and a useful load of 11,020 lb. On order by the French navy and West German Defense Ministry, the 3210 has six main rotor blades as opposed to four on the 3200. Tail rotor blades also have been lengthened and a horizontal tail fin added to aid stability. Powered by three Turmo IIIC turboprop powerplants rated at 1,320 hp. each, the Frelon has a maximum sea level speed of 135 kt., a cruising speed of 119 kt.

Soviets Eye Mockups

Paris—Russians were busy trying to extract maximum technical data from Western exhibits at the Paris Air Show while failing to produce their promised exhibits of new turbofan and turboprop transports as the show passed the midway mark last week.

The sole Russian exhibit was a Tupolev Tu-114 turboprop transport that was featured at the 1959 Paris show.

The giant Tu-114 brought a delegation of 60 Soviet technicians to Paris for the opening of the show. These technicians have been busy since arrival with sketch pads, cameras, micrometers and tape measures swarming over British and U. S. space and engine exhibits tabulating what they apparently consider significant technical data.

Soviet technicians spend hours at a single exhibit sketching, photographing and measuring equipment on display. United States technicians took a humorous view of this furious data-gathering activity, pointing out that all technical exhibits are mockups or special display engines and that the main thing the Soviets can learn from this equipment is how to build mockups for air shows. They predicted considerable disappointment in Moscow when this huge collection of data is analyzed for its technical value.

around just what is needed to replace current series of frontline aircraft in France and Germany and the Lockheed F-104 interceptor and G. 91 close-support fighter in use or planned by other European NATO nations.

Britain, with its P. 1127 follow-on, and Italy, with its G. 95, would like to see an interim replacement for the G. 91 which could be available in 1965.

Germany, while supporting P. 1127 follow-on development as a backup, is shifting to the concept of using a single aircraft for both close support and interception and has told the Messerschmitt-Heinkel-Bolkow consortium to redirect its program from a Mach 3 interceptor to an aircraft with roughly similar capabilities as the Republic-Fokker design. German Defense Ministry also recently signed a contract with Northrop, Inc., for help in designing the aircraft's weapons system package and for aid in laminar flow techniques.

France, with its Balzac—an early-model Dassault Mirage III modified to house eight RB.108s in the fuselage plus a Bristol Siddeley Orpheus for horizontal flight—and probable follow-on developments plus its agreement with Germany for joint development of high-performance V/STOL craft also is opposed to the concept of an interim aircraft.

Two other major anticipated European customers—The Netherlands, with its Fokker-Republic proposal, and Belgium—are siding with Germany and France in pushing for a single aircraft for close support and interdiction.

So far as time is concerned, Republic, which has been working on its variable sweep approach for the past seven years incorporating design data supplied by the National Aeronautics and Space Administration, contends that it can have the first aircraft of its prototype series flying by late 1965 and planes ready for squadron service approximately one year later.

Company already has devoted a total of 16,000 hr. of wind tunnel and data-reduction time to the project in the U. S. and 40 Republic engineers and management personnel will be located at Fokker in Amsterdam in the near future to advance the project in Europe.

Last week, Republic and Bristol Siddeley agreed to continue their support of a joint airframe-engine program regardless of future outside support given by U. S. or British governments or by NATO. The companies believe that the variable-sweep, single-powerplant concept will prove its superiority in the long run. Reasons cited for the single-engine concept as opposed to separate engines for lift and horizontal flight include simplification of logistic support requirements and the problems of field maintenance.

Cost Factor

Cost also is a factor, and Republic says it could cut its unit price to slightly over $1 million per aircraft if it received orders for more than 1,000 planes. Price includes instrumentation for full all-weather capability equal to that of Republic's F-105 fighter-bomber now phasing into operation in U. S. Air Force units in Germany.

With its wings retracted at a point during high subsonic flight regime, the Republic-Fokker design can revert to an interceptor role at altitude, attaining maximum speeds of Mach 2-plus. If it follows the trend of other design entries in the NATO competition, the aircraft probably would have dry weight of approximately 20,000 lb., takeoff weight in the area of 30,000 lb. As in the case of all entries, any European production would envisage multi-nation participation.

Despite Britain's current ties with Germany in the VTOL field, Republic would like to work with Hawker-Siddeley on the development end of the project, gaining data from the flight experience of Hawker P. 1127 and in turn, feeding its variable sweep and development information into the program.

Republic has spent about $6.5 million of its own funds on the program, and United States mutual aid officials and The Netherlands government recently agreed to support an evaluation by Fokker of the compatibility of engine and airframe designs. U. S. mutual aid funds, which helped support original Bristol Siddeley BS.53 development, also are being channeled into the BS.100 program.

Republic design data is currently being evaluated by U. S. Air Force, and the report on its findings should be available in late June. If the report is favorable and spurs additional U. S. funds into the project it could have a strong effect on NATO competition as a whole since it could save countries involved considerable expenditures in development programs.

General Electric, which has been working on its lift-fan principle for the past five years, says the basic design could be boosted into a supersonic system by housing the fans in the fuselage rather than in the wing.

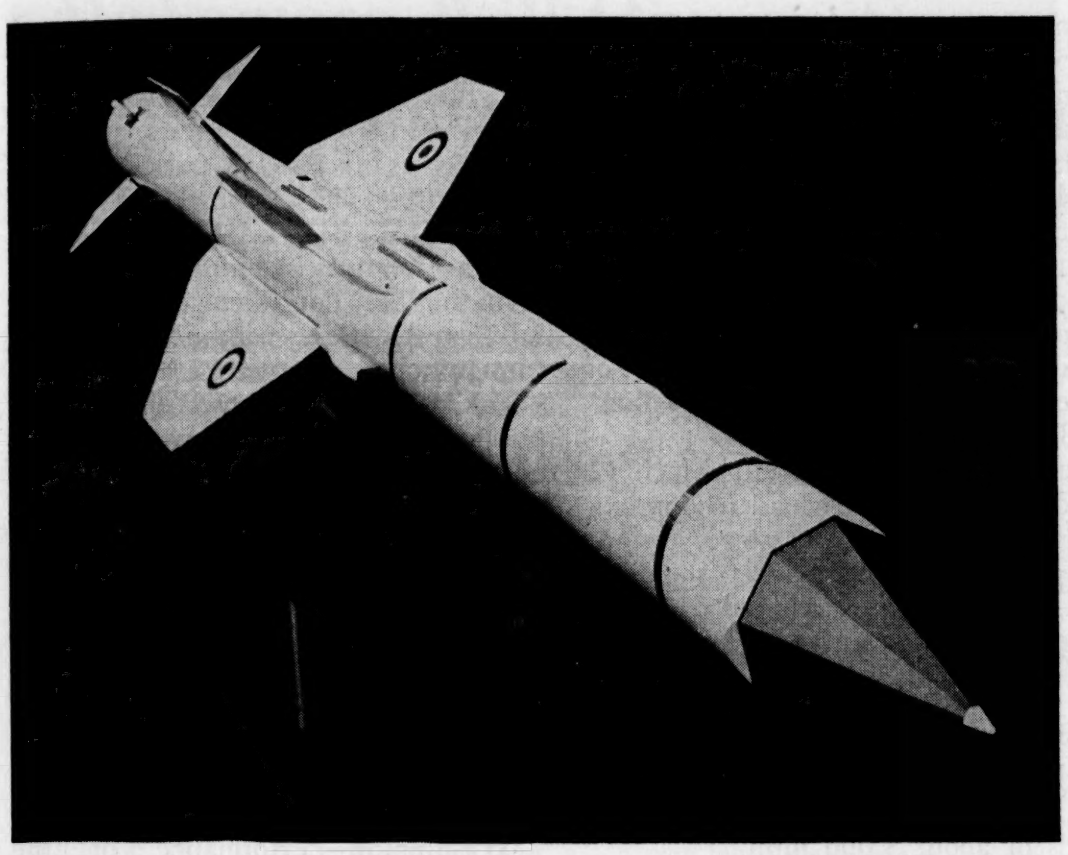
When the thrust of the two J85s is being diverted into two lift-fans and a nose control fan, small turbines mounted around the periphery of the fans boost the normal 2,500-lb. thrust of each engine to approximately 7,500 lb. each. The J85s pump low velocity, high mass flow into the fans, and a General Electric engineer connected with the project says that, through this system, they have demonstrated a .35 specific fuel consumption from an engine that has a normal rating of .9 sfc.

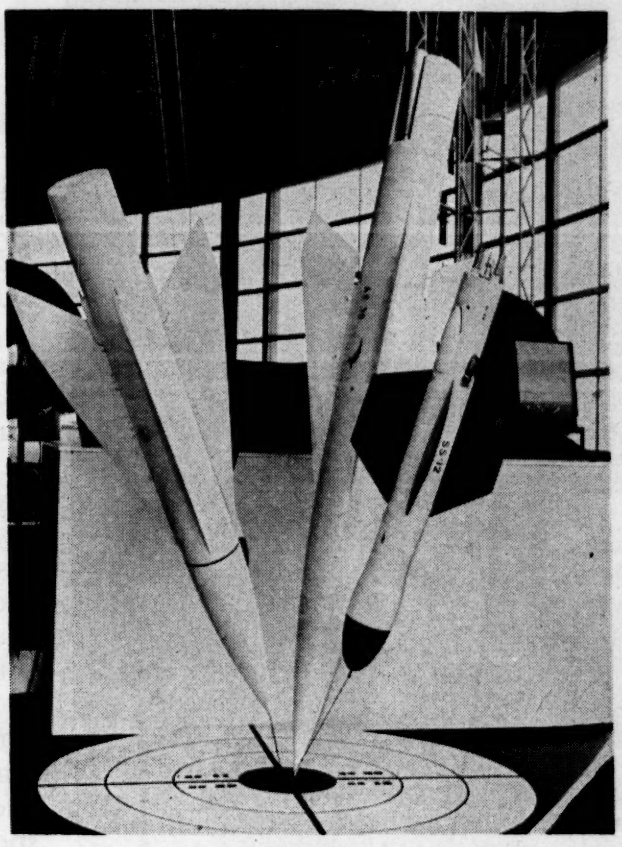
Gagarin Flight Data

Information filed with the Federation Internationale Aeronautique in Paris to document Russian claims of space altitude, duration and load-lifting records set by Maj. Yuri Gagarin in the first manned orbital flight Apr. 12 (AW Apr. 17, p. 28) reveal that the launching vehicle had six engines generating 20 million hp.

Launch site was a cosmodrome at Baikonur near the Aral Sea at latitude 47 deg. N. and longitude 65 deg. E., and landing site was near the village of Smelovka in the Ternov District, Saratov Region, according to the official Soviet news agency Tass.

Some Soviet reports said the engines used liquid fuel. While it is impossible to compute rocket engine thrust solely on the basis of the information filed, some U. S. observers speculate that the first stage of the launch vehicle generated 1.2 million lb. of thrust. Robert Truax, director of advanced development for Aerojet's liquid rocket plant, said the booster stage may have had a cluster of four 300,000-lb.-thrust engines, and the second stage may have had two 300,000-lb.-thrust engines, a propulsion configuration believed to power Soviet intercontinental missiles. Most Western observers have assumed Soviet space boosters had at least three stages.





DE HAVILLAND Red Top infrared-guided air-to-air missile was designed as a follow-on to Firestreak. Center missile in Nord Aviation display (right) is the AS-30, an air-to-ground system comparable to Martin Bullpup. Next-to-largest is earlier AS-20 air-to-ground missile. Smallest unit is ground-to-air SS-12.

Paris Show Reflects Europeans' Space, Missile Technology Efforts

Paris—European efforts to boost its technology in the fields of space and missiles were reflected in static exhibits at the Paris International Air Show.

France, anxious to become a full member of the nuclear club, displayed a number of research vehicles in high-altitude research field plus a new air-to-surface guided missile that can be adapted to take a nuclear warhead.

Great Britain, pushing booster systems for any common European space effort, displayed a model showing the British Blue Streak as first stage, French Veronique as second and adaption of the British Skylark research missile as the third.

A British spokesman said the Blue Streak combination should be capable of placing a 2,000-lb. payload into a 300-mi. orbit and that a fourth stage can be added to gain additional distance and greater payload weights.

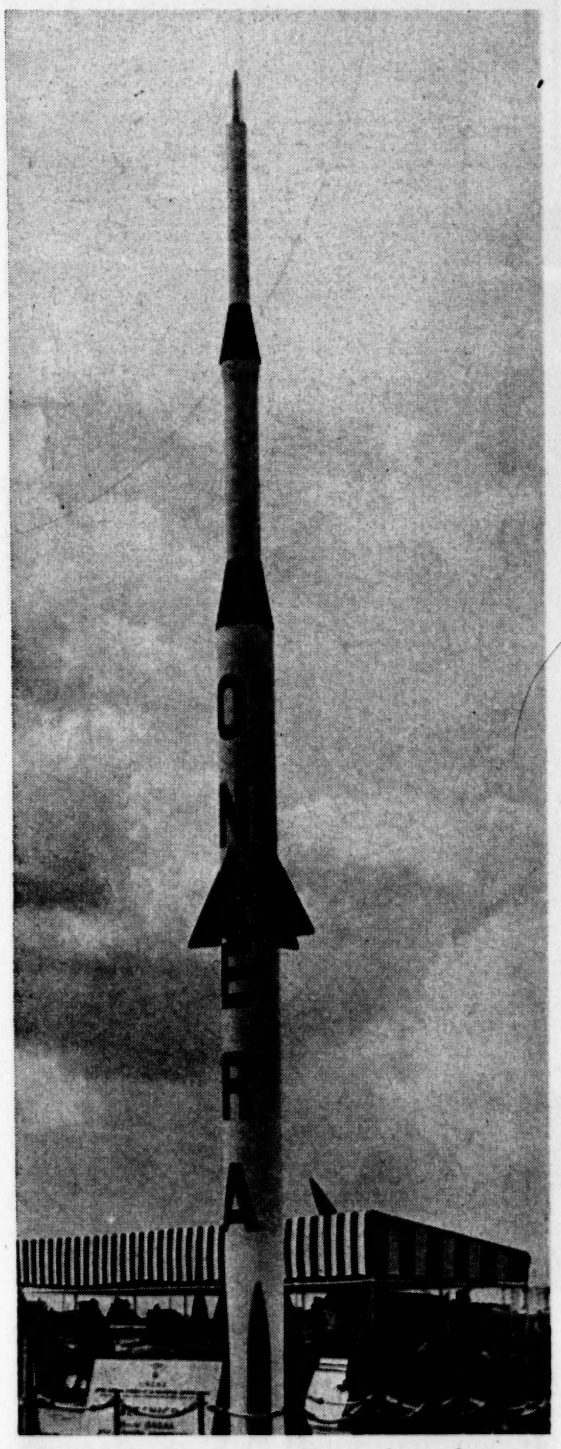
French air-to-surface missile system on display that could be adapted to a nuclear warhead is AS-30 developed by Nord Aviation. Competitor of the Martin Bullpup on the European market, AS-30 travels at supersonic speeds and can be fired from aircraft traveling supersonically at the time of launch. With body length of 11.5 ft. and range of approximately seven miles, the Mach 2 AS-30 is being built in limited quantities for an accelerated test program.

French also displayed the air-to-air Matra R-530 two stage solid-propelled guided missile with a range of approximately 60,000 ft. while the British had on hand their new Hawker Siddeley Red Top air-to-air unit designed as follow-on to the now-operational Firestreak. Infrared guided Red Top, which follows external configuration of the Firestreak with fixed wings and movable rear control surfaces, is believed on order by the Royal Air Force.

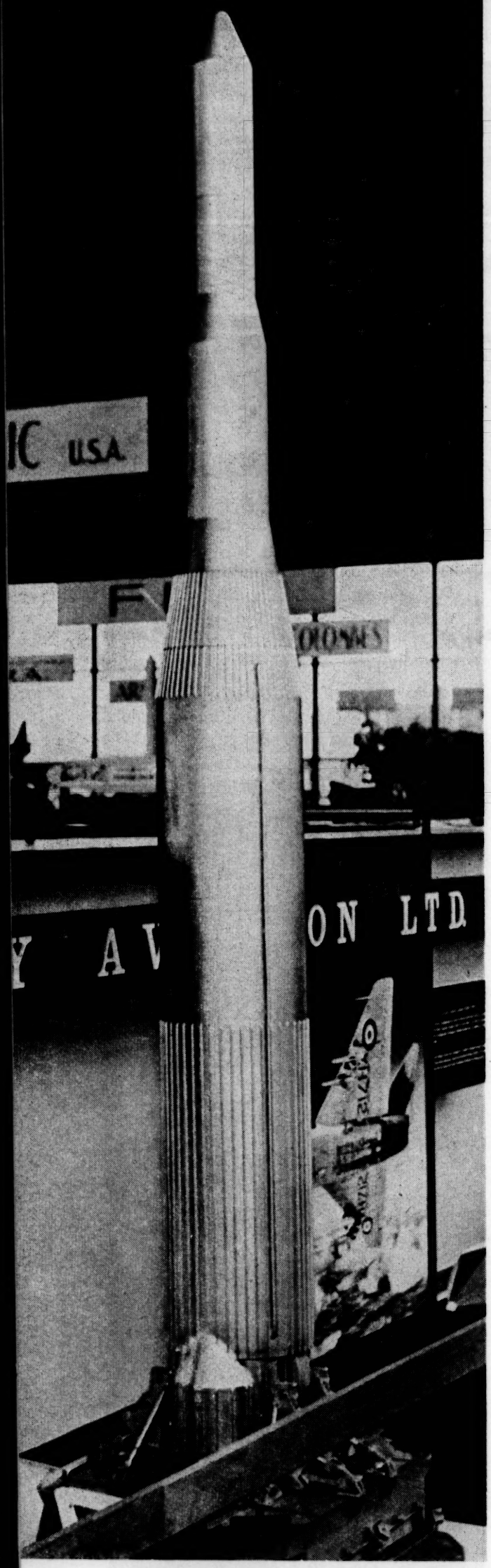
In the tactical field, the British also displayed publicly for the first time the English Electric Blue Water surface-to-surface inertially guided missile system under development for the British Army and competitor in North Atlantic Treaty countries to the U.S. Sergeant as the replacement for the obsolescing 15-mi. range Corporal. Blue Water range was not revealed, but it is believed to be about Sergeant's maximum range of 85 naut. mi.

Solid-fueled Blue Water, which the British emphasize "meets the NATO requirement for a replacement for the Corporal missile," requires only two vehicles at launch site, a three-ton launcher-transporter and a ½-ton Land Rover carrying the ground computer system. English Electric statement stipulates that Blue Water unit can move from a camouflaged position, fire and return to safety within 10-min. period.

Display of Onera, French equivalent of the National Aeronautics and Space



BERENICE three-stage research rocket was developed by France's Onera. Berenice can obtain maximum altitude of 745 mi. with 66-lb. payload or 465 mi. with a 220-lb. payload.



HAWKER-SIDDELEY model represents British space vehicle which would place a 2,000-lb. payload into a 300-mi. orbit. It envisions the use of the British Blue Streak IRBM as the first stage, the French Veronique as the second and an adaptation of the British Skylark research rocket as the third. A fourth stage could be added to obtain greater distances and/or heavier payloads.

Administration, included third Stataltex experimental high-altitude vehicle for ramjet propulsion tests and its Sepr booster.

Stataltex, which attains speeds of Mach 5-plus, has been fired twice to altitudes of slightly above 30 mi. Third Stataltex on display at the air show is scheduled to be fired soon.

French high-altitude research rockets designed to probe the fringes of space included the Antares and follow-on Berenice.

Berenice, which can attain Mach 12 speeds, can carry a payload to approximately 600 mi. as a four stage version, just over 400 mi. as a three stage vehicle. First firing is scheduled before the end of year. Antares, Onera four stage version of U.S. X-17 has been fired 12 times since 1959. Three stages carry Antares to an altitude of approximately 93 mi. when fourth stage noses over, ignites and begins re-entry tests at speeds of about 5,000 mph.

Defense Information Policy Is Clarified

Washington—Defense Secretary Robert S. McNamara has told Defense officials "when in doubt, under-classify" in clarifying his policy on military information security.

"It is essential to avoid disclosure of information that can be of material assistance to our potential enemies," he said. "It is equally important to avoid overclassification." He also noted that "in no event should overclassification be used to avoid public discussion of controversial matters."

Clarifying his recent controversial views on information security (AW May 22, p. 23) McNamara observed that the public information policies of the Defense Department require "delicate accommodation" of competing values. Flow of some information is to be restricted in some respects, but more open, responsible discussion of national defense policies and practices is to be encouraged.

Arguments on both sides of important issues must be clear, he said, so there will be a consensus of confidence in the ultimate decision. "In a democratic society the public must be kept informed . . . and has at least as much right to good news as bad news . . . we are under a special obligation to disclose mistakes and ineffective administration."

He also emphasized that public statements of what appears to be Department of Defense policy must reflect actual policy.

McNamara warned that "in public discussions, all officials of the department should confine themselves to defense matters. They should particularly avoid discussion of foreign policy matters." He said this field is reserved for the President and State Department, and Defense officials' views could be mistaken as official U.S. policy.

Defense officials, whose public speeches have been heavily censored under the Kennedy Administration, complain that they don't know how they can talk about defense without mentioning foreign policy.

Asked about a proposed directive on public information which was circulated among the services in April and which would have centralized military information functions, McNamara stated he knew nothing of the proposed directive, leading to speculation that the proposal was originated without his knowledge.

Nuclear Upper Stages Studied With Saturn

Washington—Performance of the Saturn booster using nuclear upper stages will be studied under six-month contracts by General Dynamics/Astronautics and Lockheed Missiles and Space Division.

General Dynamics contract is for $112,636, and Lockheed's is for $128,804. Both companies will study second and third nuclear stages based on Saturn H-1 and F-1 engine clusters in the first stage.

National Aeronautics and Space Administration, which awarded the contracts, also said the 10-flight Saturn C-1 booster development program starting in late summer will be made with two-stage vehicles, rather than three stages as was planned previously. Some flights will be made with dummy third stages for stability.

Two-stage Saturn, with a cluster of eight H-1 engines as the S-1 booster and six LR-115 engines as S-IV second stage, has a 20,000-lb. orbital payload capability, NASA said, and can accommodate the earth-orbiting Apollo configuration. Last four flights in the test program will carry boilerplate Apollo spacecraft payloads.

First three launches will be made with live boosters and dummy upper stages. Next three will be with live first and second stages. With their instrument compartment, these vehicles are about 160 ft. high.

Apollo boilerplate tests will be made with two live stages and aerodynamic fins attached to the booster. The system is 150 ft. high and will be the first test of the H-1 cluster at full thrust. Each engine has a design thrust of 188,000 lb.

The S-V third stage, a cluster of two LR-115 engines, has been deleted from the C-1 flight development program, but NASA said it will be used for some operational C-1 and C-2 configurations.

McNamara Will Oppose Spending Any Additional SAC Bomber Funds

Washington – Defense Secretary Robert S. McNamara plans to recommend against spending any Fiscal 1962 funds Congress should provide for extending production of Boeing B-52 or Convair B-58 bombers.

McNamara agrees with Congress that the country must be prepared to maintain manned bombers in its operational inventory at least through 1970, and "we have plans to do so. Those plans do not require the expenditure of funds in Fiscal 1962," he told a press conference, the second he has held since taking office.

Commenting on controversy over the role of the Joint Chiefs of Staff in the abortive rebel invasion of Cuba, McNamara said that the Department of Defense was fully represented over a period of weeks prior to the invasion by him and the Joint Chiefs or their representatives.

"As Secretary of Defense I am responsible for the operations of this department, and I am responsible for the actions of all the personnel in the department, both military and civilian," he said. "Any errors are my errors. They are not to be charged to others."

He stated his confidence in the members of the Joint Chiefs of Staff, calling them "intelligent, experienced, dedicated men." Asked if he expects them to continue their full terms, he replied, "I certainly do."

Discussing recent reports that there is civilian-military strife in the Pentagon, McNamara said that he meets with the Joint Chiefs at least once a week and several times over a period of weeks. Individually, he has met them hundreds of times and there have been many telephone conversations, he added.

"I think Tom Gates [former Defense Secretary Thomas S. Gates], perhaps more than any other Secretary in recent years, did much to establish a close relationship with the chiefs," he said. "I have endeavored to . . . expand on that relationship, drawing it closer and closer together."

McNamara said he believes in an "open door" policy in relationships between the assistant secretaries of defense and their counterparts in the individual services. He also favors free and informal exchange of information among government departments. He specifically mentioned Secretary of State Dean Rusk, with whom he announced this exchange policy shortly after taking office.

Discussing closing of bases, McNamara said that he had divided the largest 1,000 of the existing 6,700 bases into systems, or functional categories such as navigational training. For each of these 60 systems, the department is determining the requirements for the next five years. After these studies are completed, there will be more closings announced, he said.

He said that a delay in revealing the locations of 21 overseas bases scheduled for closing is due to prolonged negotiations with countries involved.

Kennedy Acts to Stop Missile Base Strikes

Washington—Kennedy Administration is relying on no-strike pledges plus a new labor-management commission to prevent a recurrence of the types of missile base work stoppages spotlighted by the Senate Permanent Investigations Subcommittee.

The subcommittee, headed by Sen. John L. McClellan (D.-Ark.), disclosed in recent hearings that 162,872 man-days were lost at intercontinental ballistic missile bases between the start of the program in 1956 and Mar. 31, 1961, because of work stoppages (AW May 22, p. 77).

Secretary of Labor Arthur Goldberg —after conferring with labor, management and mediation officials—announced May 26 the "no-strike, no-lockout" pledges, while President Kennedy the same day established the Missile Sites Labor Commission designed to settle disputes at missile bases.

Goldberg said the "manufacturers, construction concerns and labor unions involved in the nation's missile and space programs" had assured him they "will cooperate to avoid uneconomical operations and work stoppages at missile and space sites. . . . Now we have shown that free labor and management can respond to the responsibility of observing the national interest without the compulsion of law." However, Sen. McClellan has promised to introduce corrective labor legislation to supplement the Kennedy Administration action.

The 11-member labor commission will establish local labor-management committees at missile sites to settle disputes before they result in strikes or walk-offs and will hear disputes which cannot be resolved by the committees on the scene, according to Goldberg. After such hearings, the national commission will make recommendations for settlement. The commission's labor and management leaders will be in a position to exert pressure on the disputing parties.

Goldberg and William E. Simkin, Federal Mediation and Conciliation Service director, are chairman and vice chairman of the commission.

Public members are David L. Cole, former president of the National Academy of Arbitrators, John T. Dunlop, Harvard University economics professor and David H. Stowe, arbitrator. Industry members include Douglas Dorman, Martin Co. vice president, Edgar F. Kaiser, Kaiser Industries president and James D. Marshall, Associated General Contractors of America executive director.

Labor members of the commission include C. J. Haggerty, AFL-CIO Building and Construction Trades Dept. president, George Meany, AFL-CIO president and Walter Reuther, AFL-CIO Industrial Union Dept. president.

Goldberg said Haggerty, Meany and Reuther gave him a "no-strike, no-lockout pledge." Others giving the same pledges were representatives of General Dynamics, International Telephone and Telegraph Co., The Boeing Co., The Martin Co., Associated General Contractors, Mechanical Contractors Assn., National Constructors Assn. and National Electrical Contractors Assn.

NASA Reverses Stand On Patent Changes

Washington – National Aeronautics and Space Administration has abandoned its long standing effort to liberalize the patent clause in the space act and now tells Congress it can get along with the present patent policy.

John A. Johnson, NASA general counsel, told a House Science and Astronautics Subcommittee last week "we are not currently experiencing any major difficulties in contracting with industry because of the patent provisions" of the space act and therefore the agency is not seeking revision of the legislation this year.

The space act provides that inventions resulting from NASA contracts become the property of the U. S. government unless the NASA administrator waives the ownership right. This provision differs from usual Defense Department policy of demanding royalty-free license for the use of an invention, but not outright ownership.

In 1959 and 1960, NASA sought revision of the patent section on grounds that existing policy discouraged contractors from undertaking space agency work. A bill to revise the patent provisions passed the House but not the Senate last year.

The Senate Judiciary Patents Subcommittee last week resumed hearings on the whole patent policy question.

Hebert Is Insisting That Defense Tighten Procurement Procedures

By Katherine Johnsen

Washington—Rep. Edward Hebert (D.-La.), chairman of the House Armed Services Investigating Subcommittee, will insist that Defense Department establish "a special policing group" to spot-check waste in procurement and "put the fear of God" in contractors and contracting officers.

Following a conference with President Kennedy, Hebert anticipated that Secretary of Defense Robert S. McNamara will take action along this line shortly. He said the procedure would be similar to that followed by the Internal Revenue Service with tax returns.

"Although it might be pointed out that in some instances the IRS spent $100,000 on administrative salaries to obtain $2,000 in refunds—the amount of evasions that were averted by the check system is inestimable," Rep. Hebert told AVIATION WEEK.

Rep. Hebert talked with the President following testimony to the subcommittee that a General Accounting Office review of 2,770 different aeronautical replacement spare parts—all procured from sole sources and with a total cost to the government of over $106 million—showed that "upward of $30 million" could have been saved had the parts been competitively procured.

Noting that the allegations of waste due to sole-source procurement reported by GAO were "inherited" by the present Administration, Rep. Hebert said that the President repeated the pledge of full cooperation he has given members of Congress concerned with Defense waste. At the direction of the President, one of McNamara's first moves on taking office was to confer with Rep. Hebert, Sen. Paul Douglas (D.-Ill.), Rep. John McCormack (D.-Mass.), and other members of Congress, and to volunteer full cooperation in promoting efficiency and economy in the Defense Department.

GAO Charges

The Department is scheduled to reply June 21 to GAO's charges that unnecessary sole-source procurement—in cases where competition is available—of aeronautical replacement spare parts is costing the government millions of dollars. The delay, to permit adequate preparation, was requested by Defense Department.

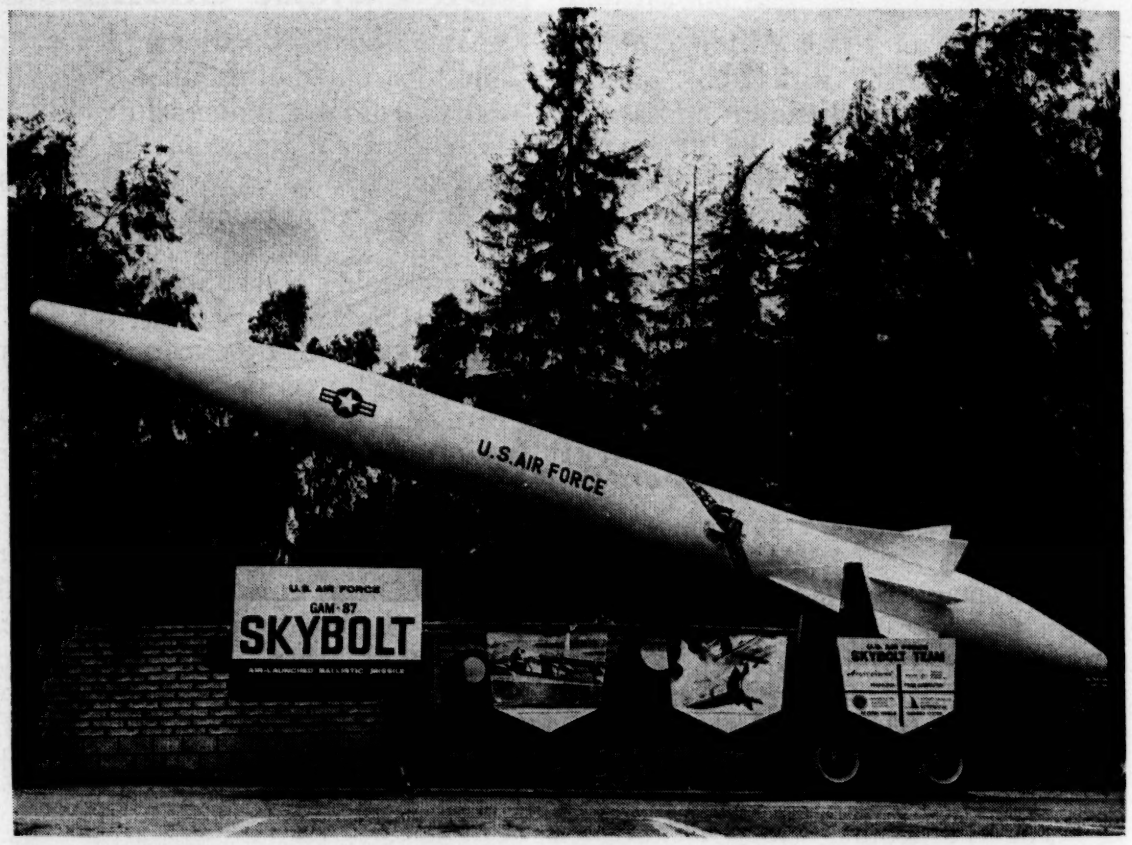
In his testimony, Comptroller General Joseph Campbell singled out for special criticism "open" contracts under which the military services agree to buy unknown quantities of unspecified parts during a year—at prices agreed upon after the orders are placed. He also criticized the services for failing to obtain technical data and drawings from sole-source contractors, and for failing to utilize the data they did acquire as the basis for competition.

To illustrate the possibilities for savings with competition, Campbell cited 12 cases, giving the bid of the former sole-source and the winning bid of the new competitor. The bids by the previous sole-source contractors totaled $114,742. The bids of the new entrants totaled $32,497—or $82,245 less.

The cases, with original contractor and winning bidder, were:

- **USAF nuts**—Boeing Co., $3,294, or $1.83 each. Valey Bolt Corp., $630, or 35 cents each.
- **USAF bolts**—Allison Division, General Motors Corp., $2,142, or 28 cents each. Dumont Aviation Associates, $841, or 11 cents each.
- **USAF clamps**—Allison Division, $20,081, or $2.25 each. Associated Aircraft Supply Co., $16,689, or $1.87 each.
- **USAF washers**—Boeing, $7,200, or 48 cents each. Dumont Aviation, $900, or 6 cents each.
- **USAF vortex generators**—Boeing, $18,698, or $7.42 each. Tri-State Machine and Manufacturing Co., $2,318, or 92 cents each.
- **USAF bracket assemblies**—Lockheed Aircraft Corp., $27,308, or $11 each. General Forming Corp., $2,163, or 88 cents each.
- **USAF bolts**—Lockheed, $8,210, or $2.59 each. Ott Brothers Machine Co., $380, or 12 cents each.
- **USAF bolts**—Lockheed, $11,840, or $9.36 each. Ott Brothers, $1,125, or 89 cents each.
- **USAF shafts**—Boeing, $7,892, or $39 each. Douglas Aircraft Co., $1,754, or $8 each.
- **Navy extensometers**—Hamilton Standard Division, United Aircraft Corp., $3,785, or $199 each. Kell-Strom Tool Co., $2,738, or $144 each.
- **Navy indicators**—Hamilton Standard, $3,188, or $199 each. Kell-Strom, $2,157, or $134 each.
- **Navy wrenches**—Hamilton Standard, $1,102, or $91 each. Kell-Strom, $795, or $66 each.

Campbell also pointed out to the subcommittee that prime contractors price parts substantially higher to the government than the amount they pay to obtain them from subcontractors. He qualified that GAO did not undertake to evaluate the cost to the prime contractors for such services as inspecting, preserving, or packaging the parts.



Skybolt ALBM Has New Configuration

Modified configuration of Douglas Skybolt air-launched ballistic missile mockup, displayed during recent Armed Forces Day observation in Los Angeles, shows removal of canard control surfaces from second stage motor casing (AW Oct. 3, p. 26), installation of four movable fins on the tail and sharply tapered nose. Control of Skybolt second stage is now by gimbaling nozzle. Warhead probably will be stabilized for impact trajectory by spin rockets. Modifications were made to ensure operational compatibility of weapon with USAF's B-52Hs and Britain's Avro Vulcan bombers.

FCC Asked to Reconsider Limits Set on Commercial Satellite System

Washington—General Electric Co.'s Communication Satellites, Inc. asked the Federal Communications Commission last week to reconsider its recent action limiting ownership and operation of a commercial communication satellite system to existing international common carriers.

The company asked the FCC to reconsider in time to permit it to attend the meeting of international common carriers which the commission scheduled June 5 to explore plans and procedures for establishing a commercial space communication system.

FCC is expected to stand by its original decision pending the results of this week's meeting. If a plan can be developed which meets the objections of some smaller carriers who fear domination by American Telephone & Telegraph Co., FCC is not expected to alter its position. If the meeting demonstrates inability of the carriers to resolve their differences, the commission may seek another solution.

The recent FCC action is viewed generally as favoring the position taken by AT&T, but the commission's statement contained a very subtle hint that AT&T should seek accommodation with the smaller carriers. FCC said that it had concluded that the formation of a joint venture composed only of existing international common carriers "is deserving of consideration and exploration as an effective means of promoting the orderly development and effectuation" of a space communication system.

The commission's action in excluding non-carriers from ownership does not meet one of the four criteria suggested by the Justice Department in its recent opinion filed with the FCC on the antitrust implications of a commercial space communication system.

However, the FCC seeks to accomplish what it believes are the objectives of the Justice Department. "We fail to see why ownership participation by the aerospace and communications equipment industries will be beneficial or necessary to the establishment of a satellite communication system to be used by the common carrier industry," the FCC said.

"On the other hand, such participation may well result in encumbering the system with complicated and costly corporate relationships, disrupting operational patterns that have been established in the international common carrier industry, and impeding effective regulation of the rates and services of the industry," the FCC declared.

The commission says it recognizes that the desire for ownership participation may in part have been motivated "by concern that without participation, the manufacturers of communications equipment will be excluded from this market by the manufacturing companies affiliated with the participating common carriers.

"Accordingly, it is the commission's intention to require that any joint venture . . . shall make adequate and effective provision, such as competitive bidding, to insure that there will be no favoritism in the procurement of communications equipment."

Satellite Frequencies Proposed by FCC

Washington – Federal Communications Commission has tentatively proposed the allocation of 2,975 mc. of radio spectrum for use by communication and meteorological satellites, with all but 100 mc. to be shared with other terrestrial radio services.

The commission emphasizes that the allocations, in the 3,700-mc. to 8,400-mc. band, are not final but were proposed to obtain the reactions and views of interested agencies and companies.

These comments are to be submitted by June 23, and FCC then plans to send proposed space frequency allocations, including any modifications, to the State Department for discussions with foreign governments. Ultimate goal is allocations recommended for adoption at the 1963 International Telecommunication Union (ITU) conference.

The FCC's present recommended frequency allocations are:

- **Satellite-to-earth:** 1,000-mc. bandwidth, of which 50 mc. between 7,650 mc. and 7,700 mc. would be an exclusive assignment while the balance would be shared with fixed and mobile terrestrial services. These shared bands are 3,700 to 4,200 mc. and 7,200 to 7,650 mc. FCC proposes that 100 mc. of the latter band be allocated for meteorological satellite transmissions to terrestrial stations.
- **Earth-to-satellite:** 1,000 mc. bandwidth, of which 50 mc. (8,350 to 8,400 mc.) would be exclusive assignment. Remaining 950 mc. of shared frequencies include 5,925 to 6,425 mc. and 7,900 to 8,350 mc.
- **Undesignated:** Another 975 mc. in two bands, 6,425 to 7,200 mc. and 7,700 to 7,900 mc., shared with mobile and fixed terrestrial services, would be available for later assignment for earth-to-satellite or satellite-to-earth services.

News Digest

Rolls-Royce is purchasing a half interest in the aeronautical engine business of D. Napier & Son, wholly-owned subsidiary of English Electric. New company will be called Napier Aero Engines. Rolls also has agreed to pay British European Airways a "substantial" sum as compensation for Tyne turbine engine problems which delayed entry of the Vickers Vanguard into BEA service for several months. BEA estimated loss at about $280 million.

Capital Airlines was merged into United Air Lines June 1 when the agreement between the two airlines was filed with the Delaware recorder of deeds, the last step remaining to consummate the merger after the U.S. Court of Appeals rejected stay petitions requested by Northwest Airlines and Delta Air Lines.

Air Force claims a world altitude record of 25,814 ft. for helicopters carrying a 1,000 kilogram (2,204 lb.) payload in a Kaman H-43B, exceeding a record set by a Russian Mi-4 which flew to 24,491 ft.

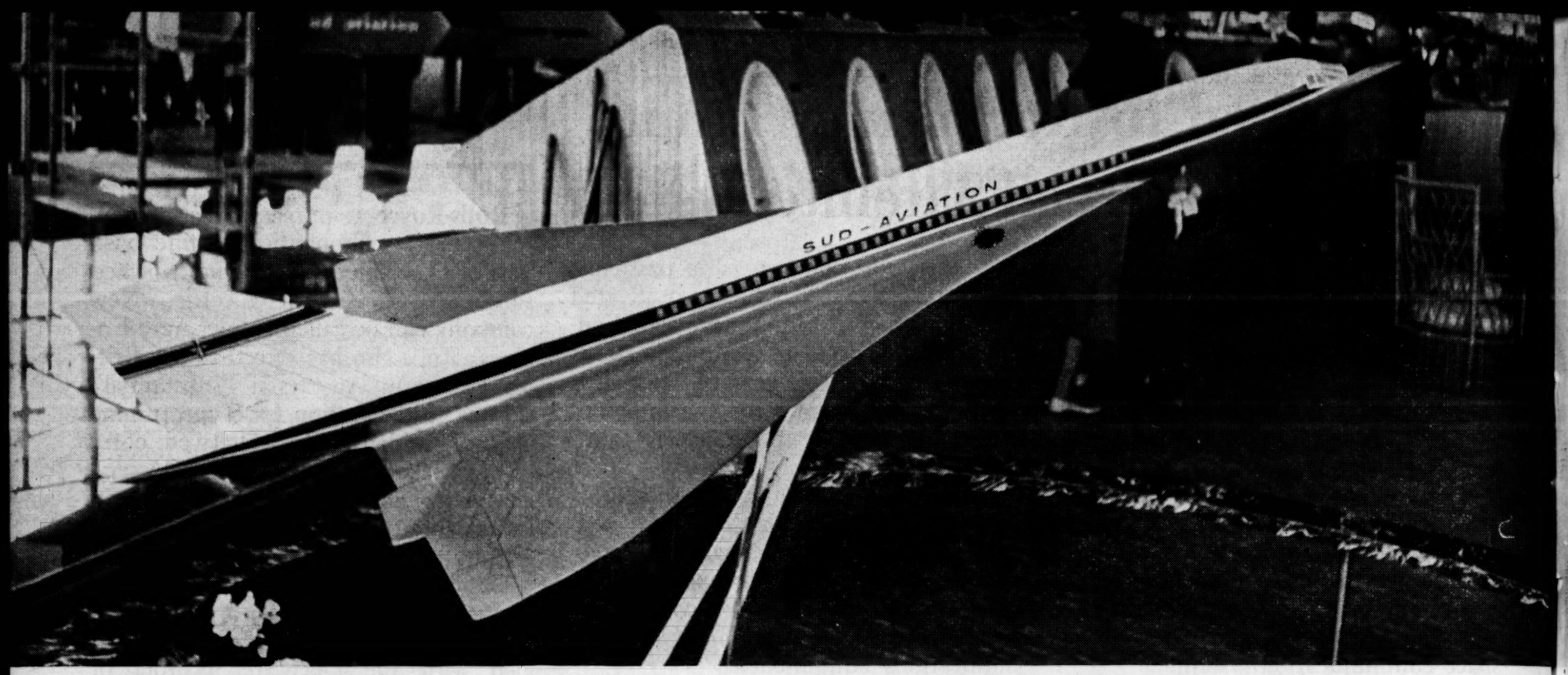
Avro 748E, a new version of the Hawker Siddeley feeder transport, is based on the Avro 748 Series 2 powered by Rolls-Royce R. Da. 7 engines. Fuselage is 6 ft. longer, permitting it to carry up to 60 passengers, and payload capacity is increased to 12,000 lb.

Massachusetts Institute of Technology has a $100,000 contract to develop a laboratory model of the Apollo navigation and guidance system for the National Aeronautics and Space Administration.

Boeing Vertol Division has a $291,000 Army contract for continued development of the Vertol 76 tilt-wing VTOL aircraft. Wings will be modified to improve stability and control during descent, and Vertol will uprate the vehicle's transmissions from 630 to 700 hp. and conduct a 50-hr. qualification program.

Federal Aviation Agency flight inspectors flew in the Umbaugh 18 autogiro for the first time on May 26 for a short familiarization flight. Initiation of FAA flight certification tests may be delayed several weeks because of previous commitments by the agency's flight test personnel.

Tiros II weather satellite exceeded its six-month estimated lifetime May 24. Infrared system failed Apr. 23, but both television cameras continue to function.



PROPOSED SUPERSONIC medium-range transport, the Super Caravelle, can be built by 1967, according to Sud Aviation President Georges Hereil. Sud will seek funds from the French Civil Aviation Ministry to help finance the development of the aircraft. The plane will fly in the Mach 2.2 region and will have an approximate range of 2,500 mi.

French Introducing Medium-Range STOL T

By L. L. Doty

Paris—French aircraft industry, in a bid to strengthen its foothold in the transport field, is introducing a series of medium-range aircraft with STOL characteristics as a means of filling the gap not covered by foreign competitors.

The new aircraft, stemming largely from designs developed under competitive bidding for a military contract, will be offered in both cargo and passenger versions.

An exception is the Potez 840, a 24-passenger transport powered by four Turbomeca Astazou turboprop engines, which is being built with private funds for delivery in 1963 (AW May 29, p. 71).

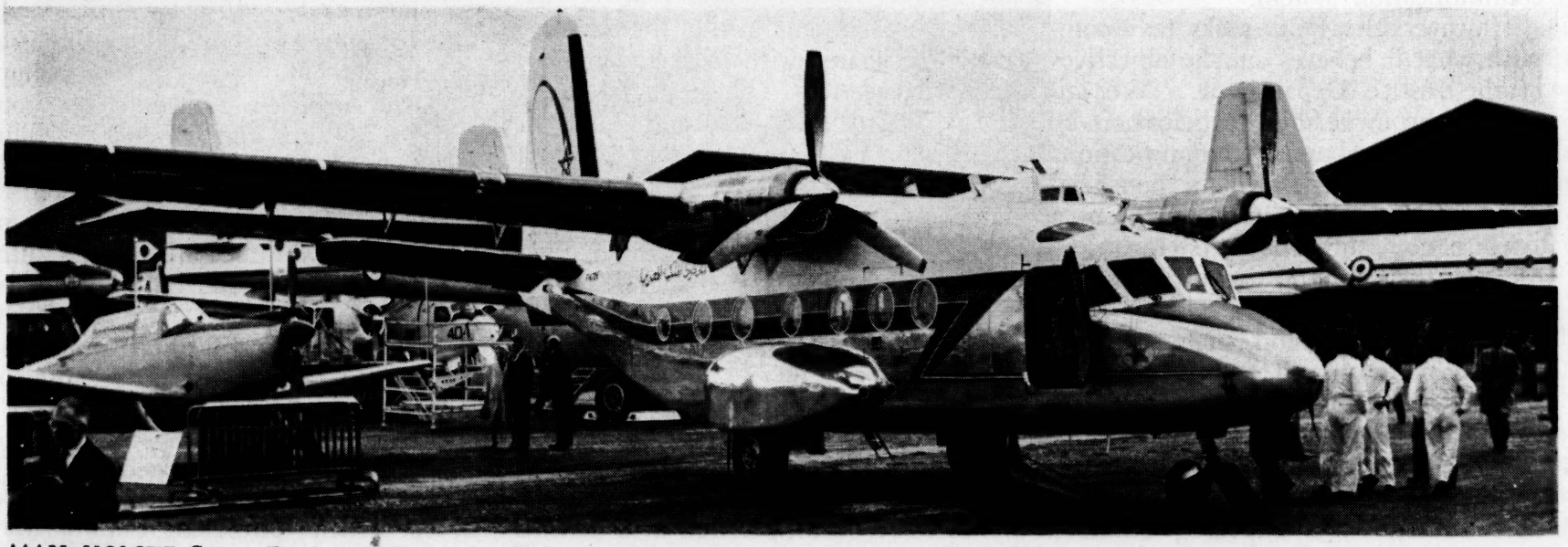
Here are the three contenders for the French military contract that were displayed here in model or mockup form at the 24th Salon International de l'Aeronautique last week:

• **Breguet 945,** light STOL employing blown-wing or deflected slipstream principle to enable it to take off after a 330-ft. run at sea level with gross weight of 22,050 lb. This aircraft appears to be the leading contender for the military contract which will be awarded in September. Commercial versions of the 945 are the 941 cargo aircraft and the 942, a mixed passenger-cargo or all-passenger pressurized transport with accommodations for up to 55 seats.

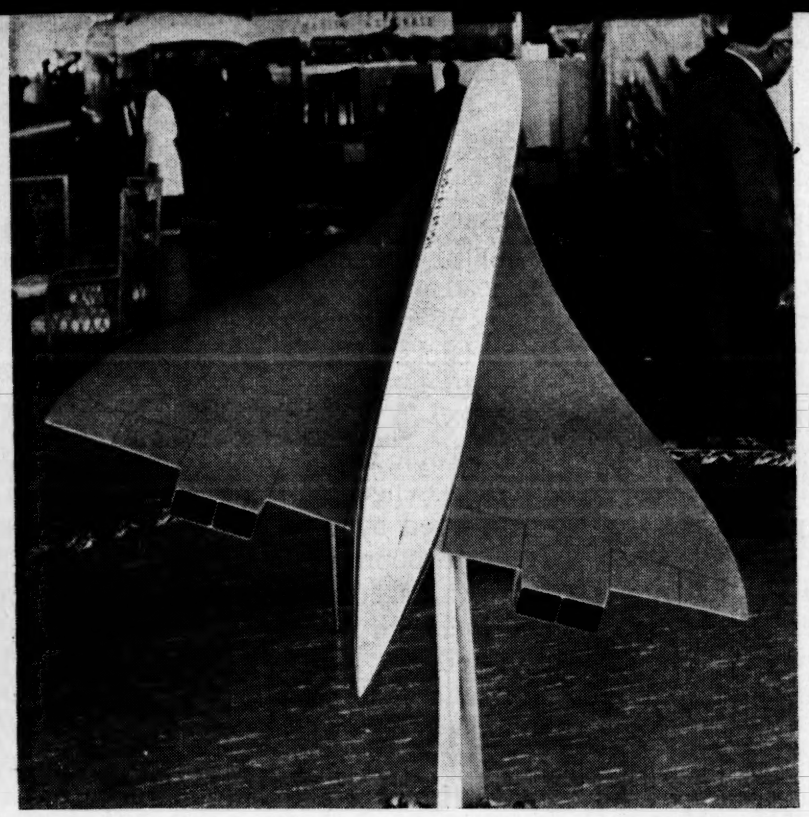
• **Nord Aviation** is making its bid for the military contract with a light-cargo version of the Max Holste Super Broussard 260 turboprop transport. The manufacturer is stressing a commercial version of the Super Broussard, and claims it has received a total of 80 options for this model. Delivery is promised for as early as January, 1962. The company will begin production of the first 20 commercial models in September.

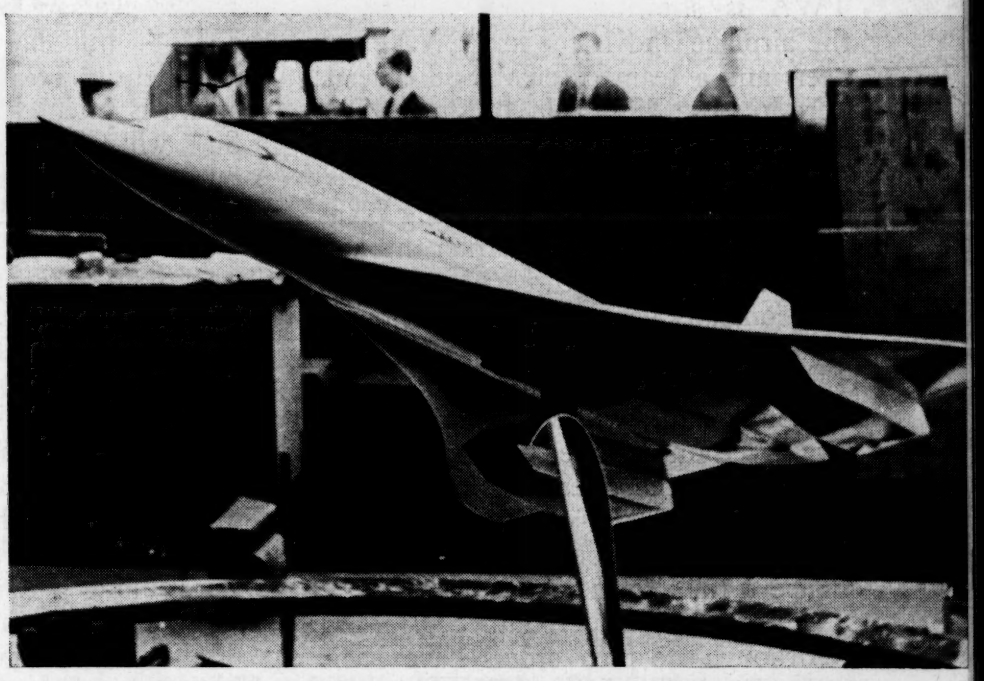
• **Marcel Dassault's** entry is the Spirale III to be built by Sud Aviation. With a 3,300-lb. payload, operating over a range of 935 mi. from a 3,000-ft.-altitude base under tropical conditions, the Spirale will have a takeoff distance of 960 ft. A prototype now is under construction. Flight tests of the prototype will determine whether the company will enter the transport field with a commercial version.

Each of three military models will be powered by two Turbomeca Turmo III turboprop engines. The Breguet 945 engines, however, will operate four mechanically-connected propellers as a



MAX HOLSTE Super Broussard prototype, built by Nord Aviation, was operated in demonstration flights at the Paris Air Show in Royal Air Maroc markings. Delivery of the 20-passenger turboprop transport is promised for January 1962. First production run calls for a total of 20 aircraft.





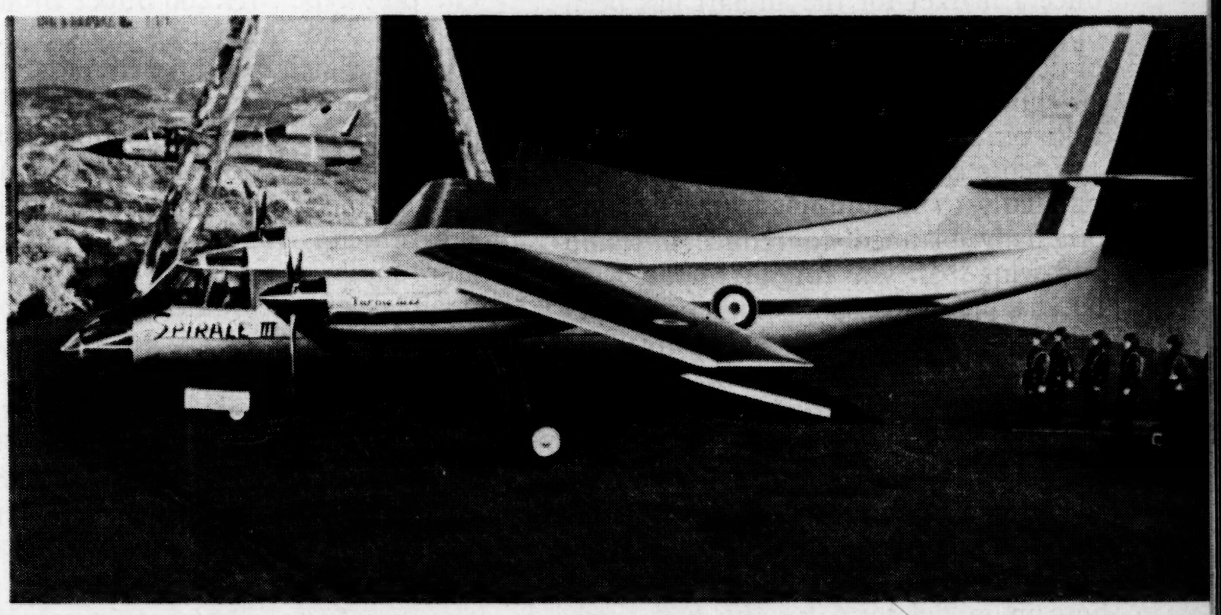
MODEL of the proposed Sud-Dassault Super Caravelle supersonic transport shows wing design configuration. Plane will be developed jointly by Sud Aviation and Marcel Dassault. Powerplants to be used on the Super Caravelle have not yet been determined. Inlet design under the wing is boxed-intake type similar to that on the B-70.

L Transports

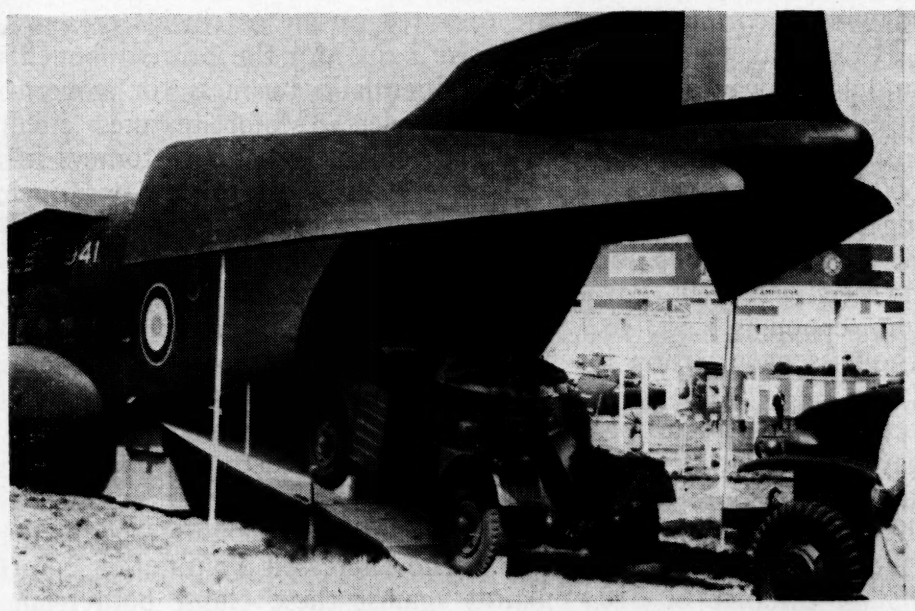
means of strengthening the deflected slipstream principle for short takeoffs. The two slave propellers will be mounted in outer wing nacelles.

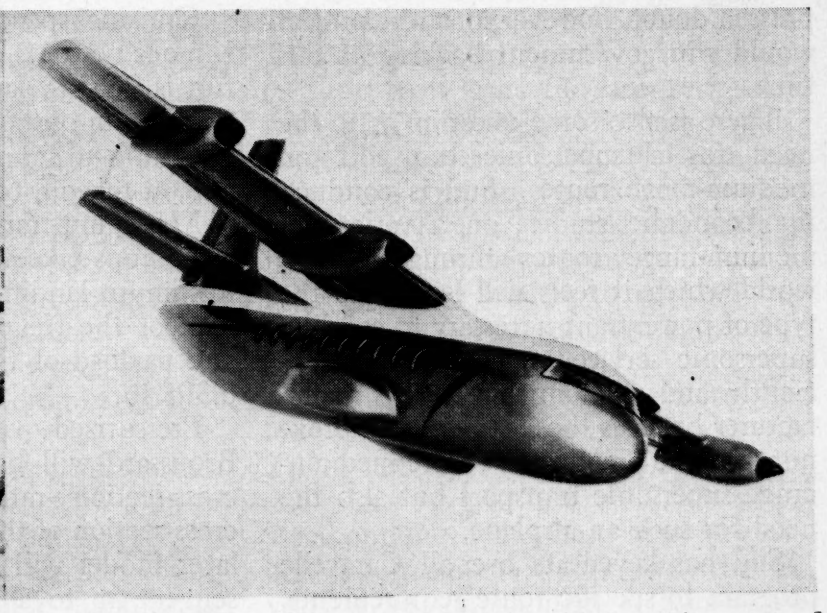
The military contract is being offered under a five-year military program which includes construction of 80 light-cargo transports required for operations in the French African community. Specific requirements are for STOL aircraft with minimum range of 950 mi. operating at a speed of 220 mph. with a 3,000-lb. payload. Total cost of the aircraft fleet is estimated at $36 million.

Meanwhile, Sud Caravelle, with a substantial number of reorders attesting to its popularity among airline operators, continues to hold its position as the mainstay of the French aircraft industry commercial wares. So far this year, Sud received reorders for a total of 10 Mark IV Caravelles. In the U.S.,



SPIRALE III, powered by two Turbomeca Turmo turboprop engines, is a military version of Dassault's Communaute transport (AW Apr. 24, p. 103). The military transport is designed for STOL operations in tropical areas. Model above shows hydraulically-operated rear ramp loading platform. The nose of the aircraft houses the observer's position. Spirale III will have a 3,300-lb. payload when operated over a 935-mi. stage length. As a medium-range cargo aircraft, the plane can be operated with a 7,700-lb. payload on 560-mi. route lengths or a 4,400-lb. payload over 740 mi.





BREGUET 941 mockup shows ramp-loading tail assembly configuration. Designed for STOL, medium-range operations, 941 will be powered by four Turbomeca Turmo IIID turboprop engines. At right is model of Breguet 942, commercial version of the 941 light cargo transport. Breguet will begin production following flight tests with the 941, scheduled to begin with prototype model this month.

TWA is showing strong interest in the airplane and last week TWA engineers and a team of eight Sud officials were in close discussion at Kansas City on operating details and costs.

Although Sud has sold a total of 116 Caravelles, it is now undertaking plans to expand the Caravelle market through the introduction of three new models. The company has started production of five Mark VII Caravelles powered by General Electric turbofan engines at its Toulouse plant, will soon move ahead with a version designed for local service or feeder airline operations. It is also hopeful that the French government will support its supersonic program in sufficient time to introduce a prototype of the proposed Super Caravelle.

Although no firm orders have been received for the Mark VII, which is powered by two General Electric aft-fan CJ805 engines, Sud wants to be in a position to promise early delivery once a market for the aircraft has been opened. General Electric flew a series of demonstration flights here during the air show with a turbofan-powered Caravelle purchased from Sud.

For its short-range version Caravelle, popularly termed Junior Caravelle, Sud originally planned to reduce airframe and wing-span size for this model but, because of increasing traffic volumes on short- and medium-range routes, has decided to retain the present Caravelle airframe and wing design and power the aircraft with Rolls-Royce Spey by-pass engines (see p. 59).

Particular interest was centered around Sud's project for a medium-range supersonic transport displayed here in model form for the first time. The aircraft, which has been under consideration for some time (AW May 1. p. 103), will fly in the Mach 2.2 region and will have a range of 2,500 mi. Sud is confident that the French government will underwrite development of the aircraft and construction of a prototype. A large number of observers here expressed doubt, however, that the project would win government backing at this time.

There is also some question as to the need for a supersonic transport on medium-range routes. Sud is conducting economic studies on a variety of medium-range routes throughout the world which it feels will lead it to the type of powerplant necessary to conduct supersonic service on such routes efficiently and economically. The manufacturer believes these studies will prove not only the practicality of the medium-range supersonic transport but also the need for such an airplane.

Sud has keyed its over-all Caravelle program to specific route requirements. For example, it is convinced that the Junior Caravelle is required for routes throughout the world that are longer than the average local service route in the U.S. but have about the same traffic density. The Junior Caravelle program is pitched to this need.

Sud will start deliveries to United Air Lines, which has ordered 20 Mark IV Caravelles, this month and will follow with four deliveries per month until the order is completed. United has set July 14 as the starting date for scheduled service with the Caravelle. A total of 14 airlines have purchased Caravelle models.

The first prototype Henry Potez 840 was flown here in a series of demonstration flights during the air show and appeared to stand out as the leading contender among French aircraft as an executive or short-range transport sales possibility. The second prototype 840 will be sold in February to Turbo Flight of Chicago which has been named U.S. sales agent for the airplane. Cost of the aircraft has been set at $500,000.

The prototype MH.260 Super Broussard, painted in the markings of Royal Air Maroc which has taken an option for five of the aircraft, was also flown in demonstration flights throughout the 10-day air show. Short takeoff and landing characteristics of the high-wing aircraft, which is powered by two Bastan IV turboprop engines each with 986 eshp. at takeoff, were impressive during demonstration flights.

Noise level in the unpressurized prototype is extremely high but Nord has undertaken a number of soundproofing modifications to correct this deficiency. Pressurized version of the Super-Broussard, MH.262, will be produced in 1962.

The passenger cabin is small—7 ft. 2 in. wide and 8 ft. 4 in. high or a usable volume of 1,293 cu. ft.—and there are no facilities for carry-on baggage. In addition, luggage rack and clothes storage space is restricted. The cabin does contain a lavatory aft and stewardess galley forward. Baggage compartment is in the tail of the aircraft.

Cruising speed with maximum continuous power is 210 kt. Takeoff ground run is 985 ft.; landing runway distance without an obstacle is 720 ft. Fuel consumption at cruise is 503 lb. per hr. and, at takeoff, 602 lb. per hr.

Maximum range is 858 naut. mi. Maximum takeoff weight is 21,605 lb., maximum landing weight 20,720. Payload of the freight version is 8,563 lb. and payload of the passenger version is 6,305 lb.

Pressurized version of the Super Broussard will have a circular fuselage cross-section rather than the square cross-section of the original model. The later model will accommodate 26 passengers up to a stage distance of 610 naut. mi. Baggage compartments fore and aft will be provided to allow baggage space of 120.4 cu. ft.

The Breguet 942 passenger transport and 941 commercial and military cargo transport are the same in design specifications. The 942 will have a maximum payload of 12,350 lb. and will carry as many as 60 seats, installed five abreast. Seat backs fold down parallel to the floor to serve as a base for cargo loading, or seats can be removed completely. A movable bulkhead permits mixed cargo-passenger operations.

Powered by four Turbomeca Turmo IIID turboprop engines, the 942 requires a takeoff distance of 670 ft. at sea level with its maximum gross weight of 45,000 lb. Cruise speed is 215 kt.

The prototype 941 was slated for completion late last week and flight tests with this model are to be started immediately. The 942 will go into production when the 941's flight tests have been completed.

The Breguet 945 military support aircraft carries a 3,300-lb. payload over a range of 1,000 mi. at a speed of 250 mph. The aircraft can circle at 45 kt. in a turning radius of 260 ft.

The Spirale III, developed from the Marcel Dassault 415 Communaute, will have a 3,300-lb. payload when operated over a 935-mi. stage length. As a medium-range cargo aircraft, the plane can be operated with a 7,700-lb. payload on 560-mi. route lengths or a 4,400-lb. payload over 740 mi.

CAB Bureau Criticizes Airline Private Clubs

Washington—Restricted membership airline passenger clubs are labeled discriminatory by Civil Aeronautics Board attorneys, who recommend that the carriers either abandon the clubs or face enforcement proceedings which would make all such facilities available to the general public.

CAB Bureau of Enforcement attorneys have given the airlines until June 22 to answer findings that the clubs are operated on an "exclusive or semi-exclusive basis" for the primary benefit of "influential" business or government travelers. Major features cited as "objectionable" by the attorneys included the use of private terminal lounges, check cashing services, and special reservations, ticketing and baggage handling services.

With memberships ranging from as little as 1,500 members on some airlines to as many as 70,000 on others, the Bureau of Enforcement contends, such clubs violate sections of the Federal Aviation Act which prohibit unjust discrimination or unfair competition. The increased volume of complaints against these clubs, both from the general public and several airlines, has emphasized the need to remove these inequities, CAB Bureau said.

Halaby FAA Reorganization Plan Calls for Deputy Administrators

By David H. Hoffman

Washington—Federal Aviation Agency Administrator N. E. Halaby, who feels the agency has too many specialists and too few managers, will make the appointment of three deputy administrators the key change in a broad FAA reorganization now under way.

To perform "line" functions within FAA's headquarters here, Halaby plans to establish three independent offices—for administration and personnel, for operations, and for research and development planning. Each of these offices will be headed by a deputy administrator reporting directly to Halaby.

Under the deputy administrator for operations will be units very similar to the major FAA bureaus, which now control agency activities by subject rather than geographical area. Thus, functions entrusted to the FAA Bureaus for Air Traffic Management, Facilities and Materiel and Flight Standards would be transferred to the office of the deputy administrator-operations, as would the offices of international coordination and medical research.

Alan L. Dean, now assistant administrator for management services, appeared last week to be Halaby's choice for deputy administrator for administration and personnel.

Deputies for operations and for research and development planning had not been selected, but FAA was actively screening and interviewing potential appointees both from within the agency and from private industry in an effort to staff the high-level offices by early September.

Designed to decentralize the over-all administration of FAA business, Halaby's reorganization plan will contain two other changes of major importance:

- **Formation of five** advisory boards composed of senior agency officials. These boards would function as staff units and exercise no direct control over the deputy administrators.
- **Appointment of assistant** administrators to head the six regional offices of the agency. The assistant administrators would replace the present regional managers, who, despite their titles, have only housekeeping powers.

Oscar Bakke, formerly director of the Bureau of Flight Standards, was named assistant administrator for the Eastern Region last week in a move that foreshadowed the sweeping reorganization. Bakke's assignment is to draft details of a "transition plan" or pilot program which other regions may utilize as a working model.

Bakke's forthcoming report is expected to call for virtual duplication of the FAA headquarters structure in each of the agency's six regional offices. Meanwhile, Bakke's deputy, George C. Prill, has been appointed director of the Bureau of Flight Standards.

Halaby's first appointment to one of the advisory boards is Lawrence C. Elliott, former manager of Region One, now the Eastern Region which covers the District of Columbia, New York, all of New England, Pennsylvania, Ohio, Virginia, West Virginia, Kentucky, Maryland and Delaware. Elliott will head the "general" advisory board. Other boards yet to be appointed will deal with congressional liaison, public relations, legal and scientific problems.

The present FAA chain of command runs from field office to region to bureau to administrator, but responsibility blurs in the link between region and bureau. A regional air safety official, for example, reports directly to his supervisor in the Bureau of Flight Standards here. Other reports from the same region are funneled upward to other bureaus in FAA's Washington headquarters, giving rise to a problem in coordination. The result, according to Halaby, is four agencies instead of one.

Under Halaby's reorganization, decentralization would be achieved by delegating far broader executive authority to the assistant administrators. From them, the chain of command would run upward directly to the deputy administrator for operations, who could farm out problems to the appropriate bureau under him.

Hughes TWA Financing Delay Fails

Howard Hughes' unsuccessful attempt to delay Trans World Airlines' $111 million debenture offering raised the question of TWA's obligation to purchase 13 Convair 990s on order by Hughes Tool Co. in addition to four Convair 880s Hughes Tool will receive from its original order of 30.

TWA, which refused to postpone the offering while the Tool Company arranged for an underwriting of its obligation to buy up to $100 million of the debentures, said that TWA lawyers had found no merit in the Hughes claims.

These claims included assertions by Hughes Tool of conflict of interest by those now controlling TWA, that the majority voting trustees appointed under the financing plan were representing the lenders and not the Hughes stock interests, that Hughes was coerced into the voting trust agreement, and that this compulsion warranted termination of the voting trust. Hughes Tool said it is investigating a suit against the lenders, the majority voting trustees—Ernest R. Breech, now TWA chairman, and Irving S. Olds—and the individual directors controlled by the majority.

Hughes warned TWA that it might make these assertions if the request for postponement was not granted. When it was refused, Hughes wrote the Securities and Exchange Commission that the registration statement for the debentures might be deficient in certain respects and followed this with a letter to TWA and the SEC, dated May 19, with the assertions as to the voting trustees and the possible liability of TWA for the aircraft.

Three days after the May 19 letter, the New York law firm of Simpson, Thatcher & Bartlett that had prepared the letter for Hughes withdrew from the matter, citing a conflict of interest. The firm is general counsel for Lehman Bros., one of the TWA underwriters. However, Chester C. Davis, the member of the firm who had actually written the letter, resigned from the firm to continue representing Hughes.

The prospectus, which was cleared by the SEC, disclosed for the first time the exact number of Convair 990s on order by Hughes Tool. Cost of the 17 airplanes was set at $75 million.

Hughes' letter said deliveries would be on comparable schedules to those of a major competitor, American Airlines, and would be sooner than Boeing 707-120Bs TWA subsequently ordered.

New financing will be required for the $187-million Boeing order, with TWA borrowing $147 million of it. TWA expects to borrow $30 million on short-term loans and later retire this with $147 million in long-term funds. Generally the same group of banks and insurance companies involved in the current financing are expected to take part, and they may require a provision permitting the lenders to demand full payment if the voting trust agreement is terminated.

Hughes Tool also objected to the long-term contract given Charles C. Tillinghast, Jr., TWA's new president, and plans to give him a 50,000 share stock option. Tillinghast, now 50 years old, is to receive $50,000 a year for 10 years if his employment is terminated by TWA before he reaches the age of 65. His annual salary is $75,000.

Sundstrand e-x-p-a-n-d-s jet start capabilities

—— Sundstrand's new **Cartridge-Pneumatic Starter** has been accepted by USAF for use on B-52H and F-100 aircraft. This new starter, now in production, offers complete self-containment and three-mode starting:

— Cartridge
— Pneumatic start using compressed air from ground power cart
— Cross-bleed start from idling engine

—— The new Sundstrand **Starter-Drive** recently approved for the Boeing 727 has been phased into production. It combines the two functions of engine starting and transmission of power to a constant frequency 400-cycle a-c electrical generator, in a single lightweight unit. This dual-purpose "power package" offers two more starting modes:

— Electric starting from a single 400-cycle ground power source (which also provides standby power)
— Electric cross starting from an idling engine

—— For the *ultimate* in dispatching reliability, a **Cartridge-Pneumatic Starter** can be used with the **Starter-Drive** system. This combination offers maximum flexibility and positive starting insurance under all operating conditions. Enables starting by:

— Pneumatic or electric ground power
— Cross-bleed air
— The cartridge mode for emergency or complete self-contained starting

—— *Regardless of type of aircraft*—jet, STOL, commercial or military . . . or operating conditions —poorly equipped fields, scramble starts, or maximum reliability requirements . . . *Sundstrand has the R&D and hardware production capabilities to handle your specific starting and constant speed drive needs.* Write or call your nearest Sundstrand Aviation office for complete information on system evaluations, reliability factors, production scheduling, and initial, operating, and maintenance costs.

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Foreign Lines Automate Atlantic Teletype

By Arnold Sherman

New York—Three foreign flag carriers—KLM, Air France and Lufthansa—have negotiated for the use of an automatic overseas communications system which directly connects the U.S. regional district offices of these carriers with their main offices in Europe.

The American Telephone and Telegraph Co./Radio Corp. of America System, designated AT&T 83B2, is designed to automate the transmission of regional messages overseas, circumventing the conventional manual relay station, by permitting direct, automatic access of regional messages to the overseas circuits.

AIR FRANCE equipment, newly installed for the 83B2 operation, includes console (center) which searches for stored information for overseas relay and a receiving reperforator on right.

Tailored to Needs

The new circuitry is pattened largely after the automatic communications systems utilized by America's scheduled transatlantic carriers—Trans World Airlines and Pan American World Airways. Both RCA and AT&T say, however, that although many facets of the automatic transmission are the same, the 83B2 is tailored more specifically to the needs of foreign airlines. As examples, the new system includes an automatic message-numbering system and a polling pattern capability which expedites the transmission of messages on "hold," features which were styled to the needs of the foreign flag lines.

There is a unanimity of opinion among the three carriers and AT&T/RCA that the advent of jet equipment, and its corresponding increase in communications, was the prime catalyst in the inauguration of the 83B2 system.

In the past, foreign carriers with outlying U.S. district offices have been compelled to feed information into a New York relay station where the communications were manually retransmitted to their final destination.

The AT&T 83B2 system eliminates the New York hiatus, instead funneling the messages through an extensive array of long-line circuits to their ultimate destination in the European home office.

Older System Saturated

An outgrowth of the AT&T 83B1 or Bellfast system, 83B2 was originally designed to handle domestic teletype requirements, but rapid expansion of airline district offices throughout the country saturated the older system much earlier than AT&T had anticipated. Also a more sophisticated method of transferring domestic tapes to and from overseas channels was required. In response, an RCA spokesman said, flip-flop transmitters were modified to permit the transmission of communications on a continuous tape basis while still providing automatic numbering of each individual message.

With commission of the 83B2, however, foreign carriers appear to have found a suitable "package" for their communication requirements, according to AT&T spokesmen.

The 83B2 system terminates several domestic teletype circuits in the central communications center of the subscriber. A message from Albuquerque, N. M., no longer has to be teletyped to a communications center in New York where it must be retyped and transmitted again to its final destination. Now the coded message is teletyped to a central relay center where it is automatically stored until it can be sent on its way via transatlantic lines to the main office. Transmission from a domestic way station, RCA said, is controlled by the 83B2 polling unit. The frequency of polling each unit may be regulated and controlled by the main station so as to provide greater access to the teletype network for the important or heavily loaded stations.

In terms of foreign carrier transmissions, the new system relegates the New York operation, insofar as transatlantic correspondence is concerned, to the role of an automatic relay and control station.

Messages entering the circuit must contain code directors which select and automatically activate the receiver printer at the desired station. An overseas-destined message must be code-directed, which terminates the connection in a Reperforator Transmitter, RCA said.

Another problem resolved by the new equipment is the difference between the domestic signal rate of 75 words per minute and the international signal rate of 66 words per minute. Special devices now resolve and compensate for this discrepancy. Also locally initiated priority messages may be inserted directly to the outward leg bypassing all traffic awaiting entrance to the circuit.

Division of Responsibility

Under the new system, AT&T retains the major responsibility. All landline circuitry falls under its jurisdiction—RCA enters the picture insofar as the transatlantic aspects of the communications are concerned. While the system is essentially an AT&T device, RCA has had to modify its equipment to make it compatible with the new circuitry. According to both AT&T and RCA the new system is "unique."

Advantages accruing from use of the automatic circuits are apparent. Messages are sent more speedily and, since a double typing operation is eliminated, more accurately. This appreciably relieves the present overseas communications strain.

First to have its 83B2 system activated was KLM Royal Dutch Airlines. Michael Szajna, chief of KLM communications, admitted that the airline "experienced a fair share of bugs in the

Performance-proved
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"...OUTSTANDING"

J. R. REAGAN, ASST. SUPT. OF COMMUNICATIONS, PIEDMONT AIRLINES, SAYS . . .

"We have been using the GB series of tubes for about 18 months and the results have been outstanding. I started a file card system on each GB tube we had in service . . . a lot of record keeping . . . after one year, decided it was not worth the time in keeping an hourly record due to the extremely few GB tube failures we experienced during the first year.

"We greatly appreciate the interest Sylvania has taken regarding our tube problems . . . the personal interest shown toward Piedmont Airlines."

If your tube performance is less than outstanding, replace with SYLVANIA GOLD BRAND TUBES.

Available from your Sylvania Industrial Tube Distributor

SYLVANIA
SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS
GENERAL SYSTEM

circuit during the initial test period," but he added, "the system is working as near to perfect as we dared imagine."

KLM already is taking steps to implement the communications system in reverse—from Europe to the various district offices in the U.S., although admittedly this will take some time.

Szajna said the AT&T 83B2 is a mere prelude to a computer operation in which messages will travel at the rate of 100,000 words per minute. "Nor am I visionary about this," he said. "We have already done substantial spade work in that direction."

The automatic system connects 63 KLM offices in the U.S. and Canada. "It can eventually be expanded to accommodate anywhere from 100-200 circuits without difficulty," he said.

First to order the system, according to AT&T and RCA spokesmen, was Air France. Installation delays, however, postponed formal commencement of the circuit until two weeks ago.

Initial Preparation

Two years of preparation and close liaison between AT&T/RCA and Air France communications officials preceded installation. In order to prepare itself for its new communications system, Air France had to modify its regional sales pattern—making it compatible to the demands of the new network. The airline's communications center in Idlewild was revamped. Air France manager of communications Leonard Brown estimates that the system will cost the airline "about $400,000 a year." (Air France's total communications budget is $1 million a year.)

"The problem," according to Brown, "was simply how to tie in 44 district regional offices with the home office in Paris. Manual retransmittal was expensive, tedious and slow. In order to prepare us for the automatic circuit [83B2] we needed a 12,000-mi. long-line teletype circuit which follows geographical configurations corresponding to regional spheres of commercial activity. Each regional head office and its associated district offices are connected to their respective long-line circuits. Code selectors and relays permit direct communications between each other and overseas.

"In addition to the obvious advantage of expediting messages," Brown said, "the new circuits will make for a more compact operation here at Idlewild." Air France employs 37 specialized personnel in its North American communications network.

Brown estimated that 85% of all messages transmitted over the overseas circuit pertain in some manner or form to reservations.

Complementing Air France's long-line circuits is its new operations communications center at Idlewild and Los

Angeles. These auxiliary communications comprise closed-circuit TV weather briefing, facsimile reception of weather maps from the Washington Weather Bureau, a base station VHF for direct liaison with various airport services and monitoring equipment on aircraft conversations, Brown said.

Another unusual device complementing the French carrier's over-all communications modernization is a monitor control board which permits a supervisor to monitor lines of reservation clerks, feeding them information when they are in doubt without the caller's awareness of the three-way transaction.

Lufthansa to Follow

Following directly on the heels of Air France and KLM is Lufthansa German Airlines. Ursula Mueller, communications manager for North America, said the airline expects implementation of the system by fall "if not sooner." "About 50% of our traffic is relayed," she pointed out. "The automatic selection into cable channels will relieve a tremendous burden from our operators."

Lufthansa expects to connect 50 offices when the system becomes operational.

Sabena Belgian World Airlines is giving serious consideration to the 83B2 system and may become the fourth international carrier to install it.

A new automatic message center with a capacity for handling up to 4,000 messages a day was recently inaugurated at Brussels National Airport but a Sabena official said "the new system doesn't negate our interest in the 83B2 and may tie into it."

Swissair and Alitalia have expressed interest in the new system.

The 83B2 is not compatible with the needs of all airlines. AT&T and RCA spokesmen pointed out that each carrier must gage the extent of its own communications problems with financial outlay and space requirements.

Air Union Agreement Ratification Prelude

Paris—National carriers from four West European nations—Alitalia, Air France, Sabena and Lufthansa—have completed negotiations and now are requesting their respective governments to ratify the Air Union agreement which would unite the carriers for policy planning and equipment purchases.

Final parliamentary ratification is not expected before the end of this year or early next year and it is possible that portions of the carrier agreements may have to be renegotiated due to government intervention (AW July 25, 1960, p. 37).

Licensing Board Ends Hearings On Cunard's North Atlantic Route Bid

London—British Air Transport Licensing Board last week concluded hearings on a controversial plan to put two British carriers on the lucrative North Atlantic route, amid reverberations from the British Parliament.

The Board took under advisement closing arguments by Cunard Eagle Airways, Cunard Steamship subsidiary which has applied for the route, and British Overseas Airways Corp., largest British nationalized airline. BOAC has opposed the request on grounds of material diversion of traffic at the taxpayer's expense (AW May 29, p. 35).

Final result probably will not be known for some months, although Norman Ashton Hill, Cunard Eagle director, entered a plea for an early decision, pointing to myriad problems associated with starting new service. Cunard Eagle has two Boeing 707-420s on order, with an option on a third, to start daily London-New York service if the application is approved.

Meanwhile, Cunard Eagle's parent company, Cunard Steamship, Ltd., came in for heavy criticism in Parliament for approving almost $14 million for the two Boeing jets while still asking for a substantial subsidy and loan, about $50 million, to build a new Queen-type ocean liner.

Parliamentary Reluctance

First indication of parliamentary reluctance to approve the ship funds came when a member of the Labor Party moved to amend the North Atlantic Shipping Bill to cut the total amount by $14 million, the amount spent for the jets. Some Labor Party members contend that the two jets would deprive BOAC, and the taxpayers, of about $30 million a year and thus "seriously impair Britain's competitiveness in world air transport."

In an unusual move, members of the Conservative Party supported the amendment to reduce the loan. The subsidy itself will be about $10 million.

Major criticism was directed against Cunard's and the government's plan to build a new luxury liner which would be "a status symbol set up for prestige value only." Cunard's chairman, Sir John Brocklebank, had told the Licensing Board that it was not a question of raising private funds, but more a matter of "unwillingness" since it would take 25 years to amortize the amount to Cunard's shareholders. Employment in British shipyards is an important factor in the ship proposal.

(The amendment to cut the loan was defeated by a vote of 135 to 89, a majority of 46 for the government.)

As the Licensing Board hearing closed, Basil Smallpeice, BOAC managing director, stressed that the state-owned carrier could carry the entire United Kingdom share of the traffic at a 60% load factor, considering its equipment orders for 15 VC. 10s and 30 Super VC. 10s.

Smallpeice denied that BOAC could have underestimated its passenger-carrying figures, as charged by Ashton Hill, claiming: "Even if we have by as much as 15%, we could still carry the whole of the British share."

Much argument centered on a definition of "material diversion," but Smallpeice finally concluded that diversion of even 1,000 passengers would be considered material and Cunard Eagle would take far more than this amount away from BOAC.

The airline's counsel, Henry Fisher, charged that Cunard Eagle had not projected any evidence on the London-New York and London-Montreal routes beyond 1965 and held that the Board, in most favorable circumstances, could not award any license beyond that year. He intimated that Cunard Eagle's projections were "optimistic and naive," and reiterated BOAC's charge that another British carrier on the North Atlantic route would be "wasteful duplication" of service.

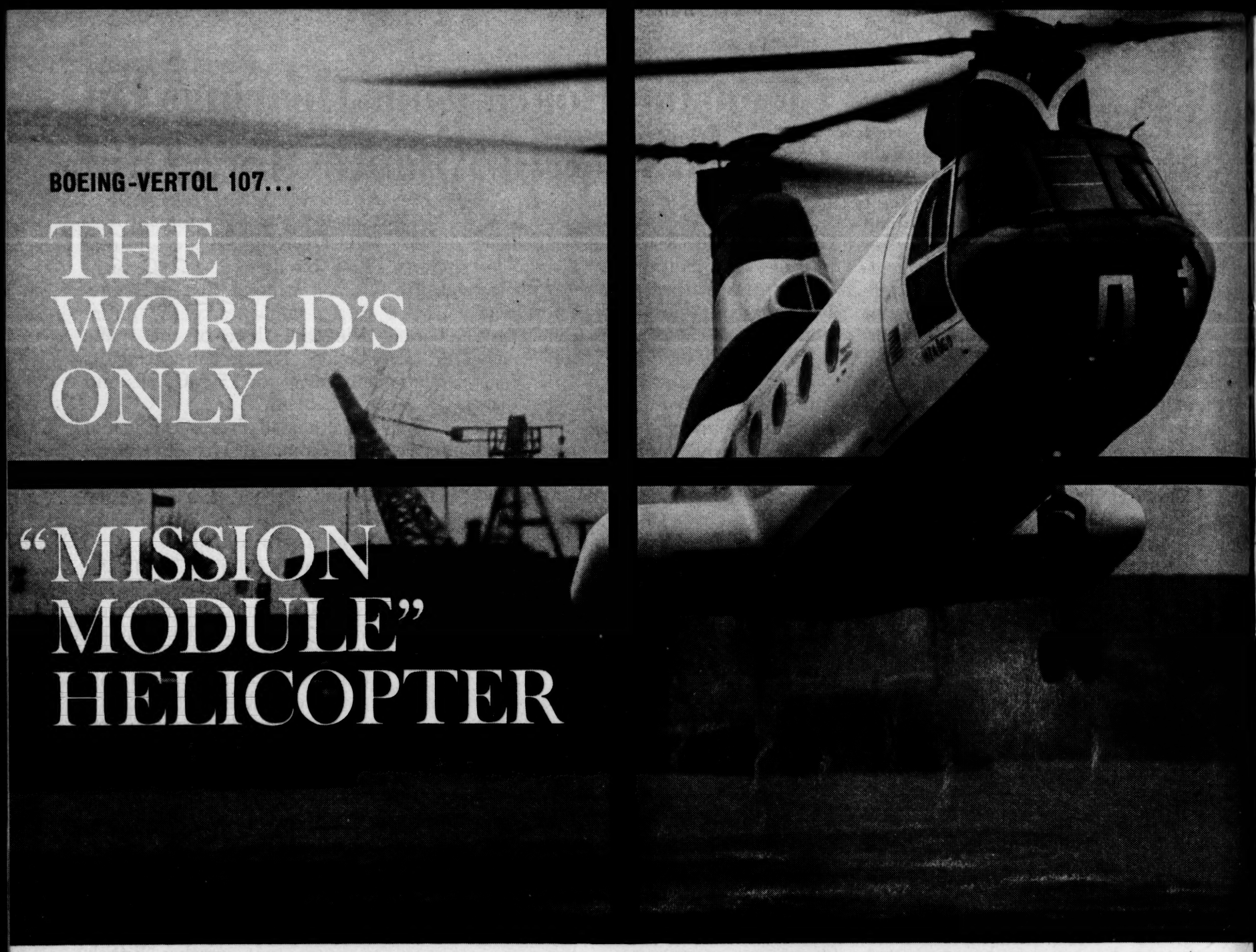
If Cunard gets approval of the application, it would start London-New York once-daily service next spring, plus three-to-four weekly runs to Montreal, using the Boeing jets. Both sides have the right to appeal to Minister of Aviation Peter Thorneycroft.

British United VC.10s

London—British United Airways last week ordered four Vickers VC.10 long-range jet transports for use on existing routes to East, Central and West Africa, and for possible use on requested routes to Africa and the Far East.

VC.10 order, worth $28 million, supplements British United's purchase of 10 BAC 111 short-haul twin-jet transports for $22.4 million (AW May 15, p. 42). The VC.10s will be delivered in 1964.

Hearings on British United's route requests will start before the Air Transport Licensing Board June 21 and are opposed by British European Airways, British state-owned airline, in the second round of a battle between the British independents and the nationalized airlines (AW May 22, p. 35).



BOEING-VERTOL 107...

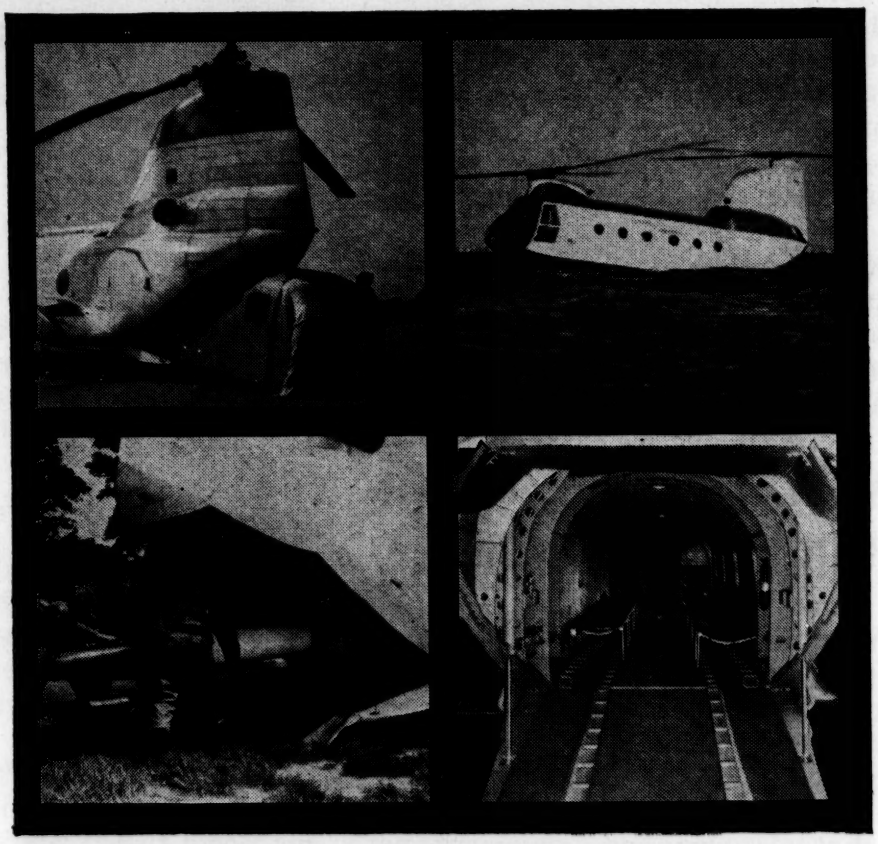
THE WORLD'S ONLY "MISSION MODULE" HELICOPTER

SIGNIFICANT FACTS ABOUT THE 107's WATER CAPABILITY

In the 107 helicopter, water landing capability has been achieved without special flotation equipment or the weight or drag penalties of floats or boat hull. Thus over-water operation can be carried out in full confidence that, should it be necessary, water landings and take offs can be made safely. The helicopter's fuselage possesses good water-taxiing characteristics. Flotation is assured by a factory-sealed fuselage of unique, flexible design; and a remarkable degree of lateral stability is provided by extended stubs on either side of the fuselage that house landing-gear support structure and fuel tanks. Elevated mounting of the rear rotor permits descent and landing in a nose-up flared attitude of as much as 30 degrees with no change in fuselage attitude required before touchdown. This is important in water landings at night, in low visibility or on glassy seas.

The "mission module" versatility of the Boeing-Vertol 107 means a high potential of all-around usefulness in operations. For example, pre-packaged, "plug-in" modules for anti-submarine warfare, minesweeping and rescue missions can be installed internally in a matter of minutes between flights. In addition, the same aircraft can tow, lift or carry heavy or bulky loads externally. Cargo of more than two tons can be speedily loaded or unloaded in the fuselage via the full-width rear ramp.

Along with its water landing capability and "mission module" versatility, the 107 offers the reliability of twin-turbine power. All in all, it is one of the most tactically and logistically useful aircraft available to the Armed Forces.



VERTOL DIVISION
BOEING
MORTON PENNSYLVANIA

Airline Income and Expenses—March, 1961

(IN DOLLARS)

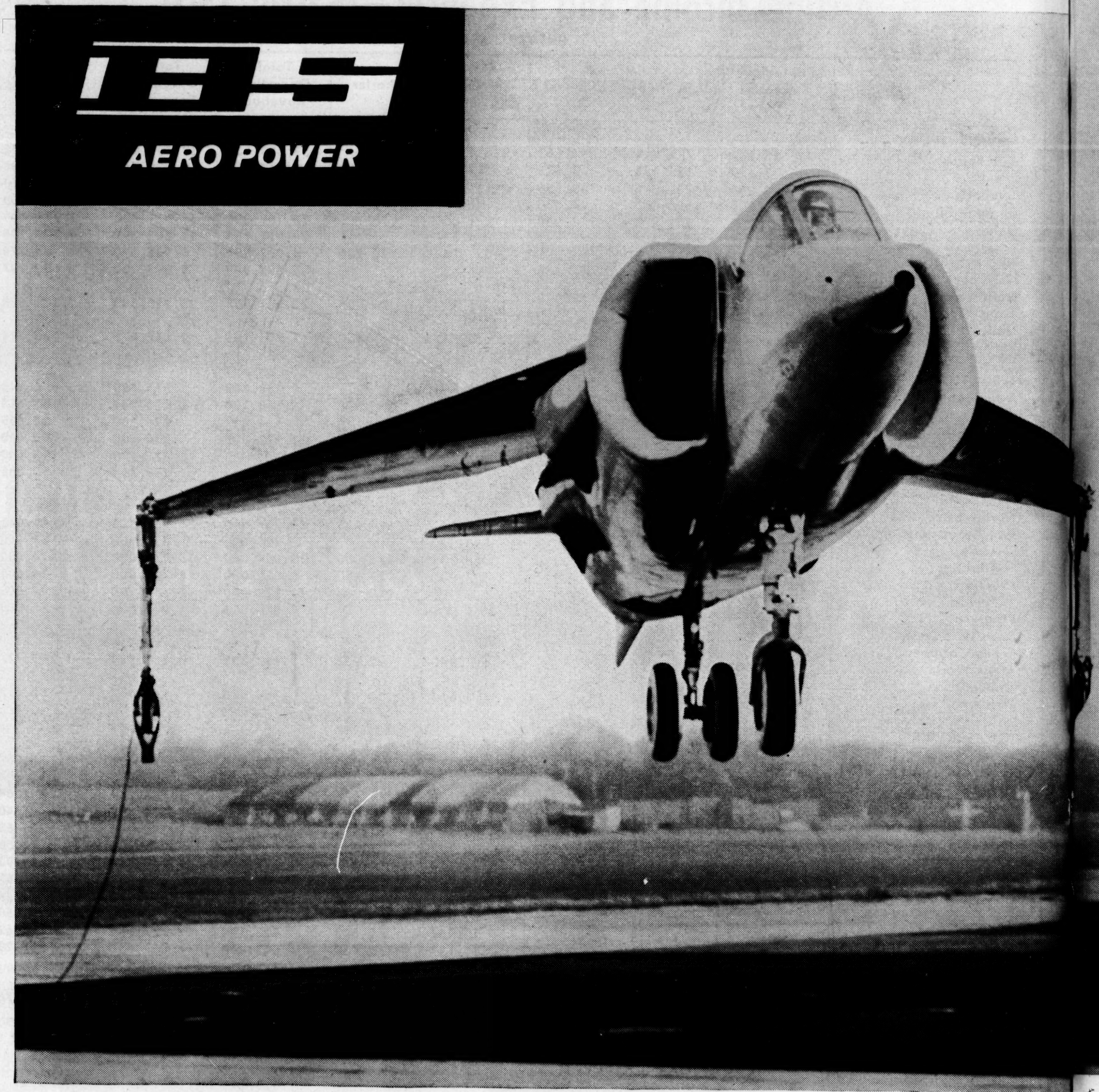
	Passenger Revenue	U. S. Mail	Express	Freight	Charter	Total Operating Revenue	Total Operating Expenses	Net Income Before Taxes
DOMESTIC TRUNK								
American	29,682,284	771,944	354,663	2,056,951	.....	33,390,409	33,490,695	−100,286
Braniff	5,591,679	185,143	68,671	242,611	16,852	6,217,886	6,238,745	−155,588
Capital	8,595,475	239,395	130,556	154,517	17,165	9,240,922	9,471,176	−416,710[3]
Continental	4,575,000	96,000	44,000	122,000	8,000	4,969,000	4,492,000	217,000
Delta	13,157,000	253,000	112,000	369,000	.....	14,109,000	11,931,000	1,955,000
Eastern	23,115,647	546,303	.....	1,059,257[4]	.....	24,937,134	24,802,392	−237,785
National	5,794,428	115,486	25,261	241,144	26,786	6,387,399	6,136,890	84,374
Northeast	5,131,507	76,589	27,668	95,635	.....	5,433,599	5,348,200	−123,797
Northwest[1]	.....	.....	.....	.....	.....	.....	.....	.....
Trans World	19,725,882	537,854	.....	1,499,323[4]	71,225	22,661,907	23,820,383	−2,331,958
United[1]	.....	.....	.....	.....	.....	.....	.....	.....
Western	1,625,894	25,298	.....	61,727[4]	9,950[2]	1,746,565	2,557,075	−933,194
INTERNATIONAL								
American	474,416	7,044	361	62,481	.....	568,808	575,656	−6,848
Braniff	677,198	22,405	.....	61,554	.....	788,100	1,070,244	−303,613
Caribbean Atlantic	334,085	3,335	.....	18,624[4]	2,876	376,357	290,282	86,695
Delta	123,000	1,000	.....	5,000	.....	137,000	236,000	−105,000
Eastern	2,925,526	61,427	.....	144,428[4]	.....	3,131,980	2,885,229	295,640
Mackey	206,104	.....	527	7,328	.....	244,896	191,794	53,206[3]
National[7]	.....	.....	.....	.....	.....	.....	.....	.....
Northwest[1]	.....	.....	.....	.....	.....	.....	.....	.....
Pan American Combined	24,643,000	2,904,000	.....	3,697,000	1,694,000	34,287,000	34,963,000	−641,000
Alaska	252,000	18,000	.....	40,000	.....	327,000	499,000	−168,000
Atlantic	10,205,000	1,289,000	.....	1,463,000	422,000	13,757,000	15,811,000	−1,116,000
Latin America	6,877,000	230,000	.....	1,187,000	129,000	8,880,000	8,982,000	−16,000
Pacific	7,309,000	1,367,000	.....	1,007,000	1,143,000	11,323,000	9,663,000	1,778,000
Panagra	1,348,000	68,000	.....	261,000	.....	1,875,000	1,906,000	−78,000
Resort[5]	.....	.....	.....	.....	.....	.....	.....	.....
Trans-Caribbean[1]	.....	.....	.....	.....	.....	.....	.....	.....
Trans World	3,495,561	746,266	.....	581,380[4]	92,963	5,180,832	6,119,739	−1,215,777
United[1]	.....	.....	.....	.....	.....	.....	.....	.....
Western	155,076	2,044	.....	4,644[4]	.....	164,516	208,817	−52,612
LOCAL SERVICE								
Allegheny[1]	.....	.....	.....	.....	.....	.....	.....	.....
Bonanza	545,295	4,106	2,736	5,754	1,030	838,785	634,306	178,267
Central	244,100	7,288	3,767	10,668	1,347	533,367	563,963	28,604[3]
Frontier	615,067	20,908	7,473	30,706	1,074	1,219,538	1,103,747	104,264
Lake Central	416,994	8,394	8,390	3,879	57	756,207	736,499	4,840
Mohawk	905,974	32,762	14,106	16,389	26,166	1,371,417	1,300,448	26,462[3]
North Central	1,171,228	37,315	35,765	30,393	2,990[2]	1,961,379	2,005,923	−65,650
Ozark	649,130	16,191	16,724	20,600	1,857	1,097,256	1,069,014	10,493
Pacific	529,046	13,046	2,640	7,791	70,132	958,936	864,151	64,862
Piedmont	614,232	10,553	6,533	11,807	10,710[2]	1,041,239	1,024,923	−6,544
Southern	445,390	17,686	5,194	12,659	7,838	839,569	812,496	9,859[3]
Trans-Texas	454,576	11,818	6,275	13,051	2,823	823,194	777,680	38,862
West Coast	573,127	12,638	3,030	11,137	2,064	1,043,464	937,606	86,629
HAWAIIAN								
Aloha	401,893	2,355	.....	5,360	.....	473,061	408,478	35,576[3]
Hawaiian[1]	.....	.....	.....	.....	.....	.....	.....	.....
CARGO LINES								
AAXICO[5]	.....	.....	.....	.....	.....	.....	.....	.....
Aerovias Sud Americana[1]	.....	.....	.....	.....	.....	.....	.....	.....
Flying Tiger[1]	.....	.....	.....	.....	.....	.....	.....	.....
Riddle[1]	.....	.....	.....	.....	.....	.....	.....	.....
Seaboard World[1]	.....	.....	.....	.....	.....	.....	.....	.....
Slick	.....	.....	.....	.....	262,092	314,975	440,258	−154,576
HELICOPTER LINES								
Chicago Helicopter	113,569	135,898	.....	.....	.....	249,907	269,164	−19,538
Los Angeles Airways	21,352	15,557	13,240	.....	37	139,877	130,937	9,979
New York Airways	85,900	3,839	3,728	2,704	.....	293,919	318,479	−28,469
ALASKA AIRLINES								
Alaska Airlines	187,872	59,707	571	41,370	157,732	673,317	695,912	−4,181
Alaska Coastal	74,690	9,322	.....	8,369	4,506	181,474	161,932	17,413[3]
Cordova	9,308	8,374	.....	10,435	29,108	110,215	93,614	15,490
Ellis	39,200	4,000	.....	5,700[4]	1,000	96,900	108,300	−11,600[3]
Kodiak[1]	.....	.....	.....	.....	.....	.....	.....	.....
Northern Consolidated	58,120	69,273	.....	35,754	9,374[2]	258,793	284,500	−16,692[3]
Pacific Northern	470,670	104,572	3,717	108,961	4,226	897,522	924,207	−29,975
Reeve Aleutian	122,424	42,783	.....	39,584[6]	17,871	227,509	196,933	31,642
Western Alaska[1]	.....	.....	.....	.....	.....	.....	.....	.....
Wien Alaska	53,221	58,575	.....	31,740	49,197	365,953	346,638	11,700
Avalon Air Transport[1]	.....	.....	.....	.....	.....	.....	.....	.....
Samoan[1]	.....	.....	.....	.....	.....	.....	.....	.....

[1] Not available. [2] Non-scheduled transportation or other transportation. [3] Net operating profit or loss. [4] Property.
[5] Operations suspended. [6] Includes excess baggage. [7] No overseas operations this month.

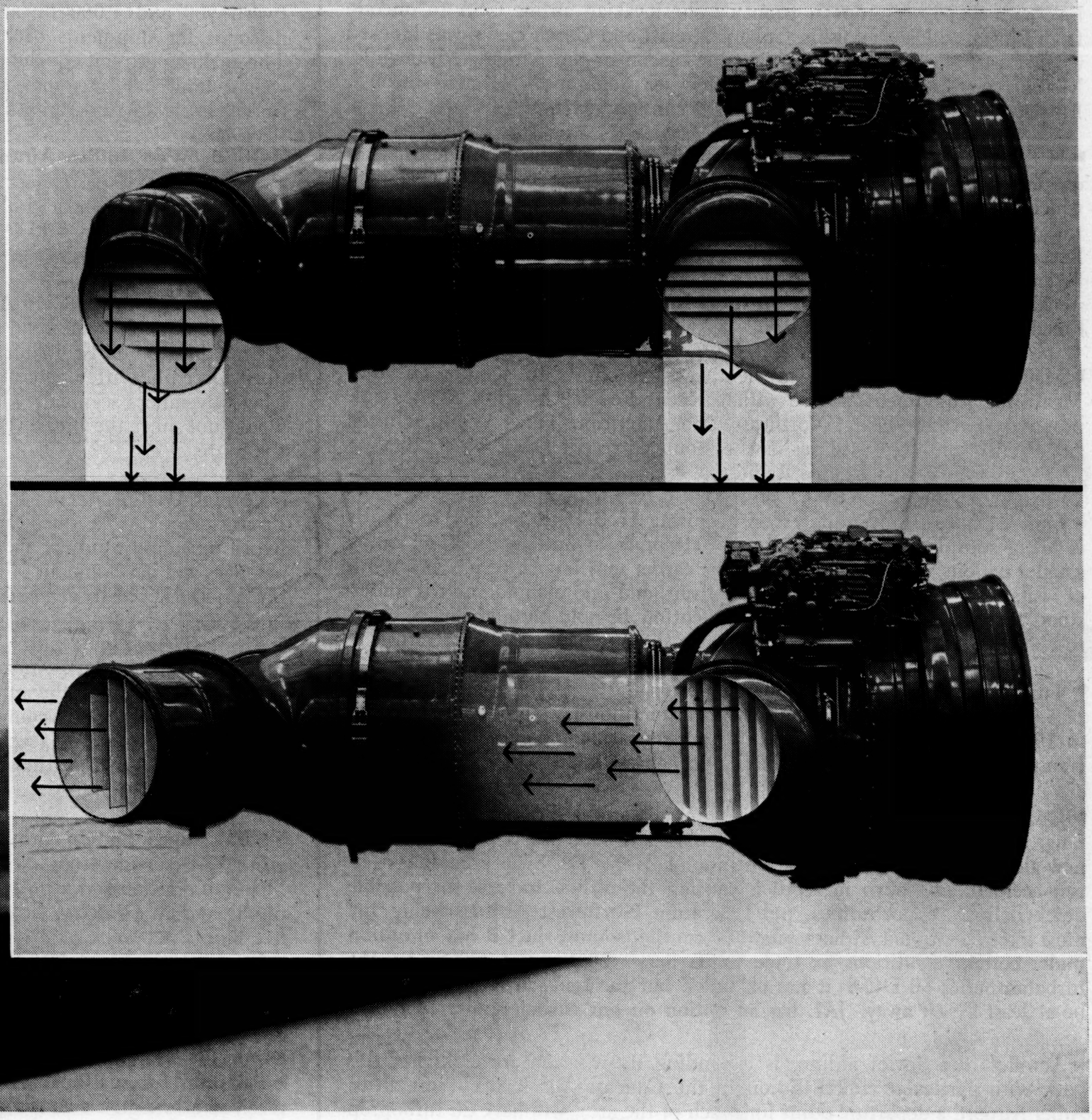
Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

BS

AERO POWER



LIFT and THRUST from ONE ENGINE the revolutionary BS 53 Pegasus turbofan



The new Bristol Siddeley BS 53 Pegasus high-ratio turbofan represents a major engineering breakthrough in the field of aircraft propulsion.

Because the Pegasus can be fitted with movable nozzles evenly disposed around the centre of gravity which give directional control to its total thrust, this remarkably versatile engine provides the airframe designer with *a single power source for all conditions of flight.*

VTOL, STOL and normal take-off capability in the same aircraft. Suitable for subsonic or supersonic applications.

High cold-flow ratio gives high thrust for low weight, low fuel consumption and low noise level.

Conventional installation. Operational simplicity. Independent of all fixed ground installations.

Problems of ground erosion, recirculation and ingestion of debris reduced to a minimum.

The Bristol Siddeley Pegasus has already been selected for, and is now undergoing trials in the Hawker P 1127 VTOL light strike fighter and is supported by the Mutual Weapons Development Programme for NATO.

For further information please write to: Bristol Aero-Industries Limited, 10210 Pie IX Boulevard, Montreal North, PQ, Canada.

BRISTOL SIDDELEY ENGINES LIMITED TURBOJETS—TURBOFANS—TURBOPROPS—RAMJETS—ROCKET ENGINES—MARINE AND INDUSTRIAL GAS TURBINES—MARINE, RAIL AND INDUSTRIAL DIESEL ENGINES—PISTON ENGINES—PRECISION ENGINEERING PRODUCTS.

AIRLINE OBSERVER

► Russia has been thwarted by Portugal in its latest attempt to gain an air link with Cuba. A proposal from Czechoslovakian airline CSA to operate from Prague to Havana, using Cubana aircraft and Czech crews, was blocked when Portugal refused landing rights at Lisbon or the Azores. Meanwhile, Moscow continues to ship a steady flow of propaganda materials through Europe to Havana as standard air freight consignments.

► **U. S. bilateral negotiators are placing increased emphasis on traffic capacity restrictions in talks with foreign governments seeking new routes. Japan, which began bilateral talks last week, will face a tough bargaining position on this point in its demands for entry into New York from San Francisco. Recent bilateral negotiations with India were recessed after the U. S. refused to expand Air-India's flight frequency into New York from five to seven weekly flights on grounds that Air-India International is carrying 98% Fifth Freedom traffic into this country.**

► Major trunk carriers have accelerated their efforts to acquire Distance Measuring Equipment in line with a recent Federal Aviation Agency rule proposal. Eastern, Delta, Northeast, Pan American, Trans World, United and Pacific Southwest Airlines have announced recent DME orders totaling $2.8 million from the Collins Radio Co.

► **United Arab Airlines' interest in acquiring U. S.-built turbojet transports is being stimulated by manufacturers' attempts to find methods of aiding smaller nations in financing orders. The carrier may buy three jets as a result of visits from Boeing, Douglas and Convair, and one manufacturer is understood to have proposed that Egyptian cotton be sold through Swiss banks to help the United Arab Republic finance the purchase of new aircraft.**

► Turbojet equipment, which now comprises 7.7% of the total world fleet of 5,014 aircraft, produced 30% of the airline industry's productive capacity in 1960. International Civil Aviation Organization reports that turboprop transports, representing 14.4% of the fleet, provide 20% of its capacity.

► **Japan Air Lines board has authorized purchase of additional DC-8s. Long-range turbofan equipment would suit JAL, and Douglas is pushing sale of new aircraft. However, JAL's loss of one of its five DC-8s in a landing overrun accident at Tokyo in April is causing the airline to look for possible quick delivery opportunities, purchase from Northwest Airlines being the most likely. National Airlines might be another source, since it has an option under certain conditions to trade in its Series 20 turbojet DC-8s on the turbofan Series 50 DC-8s it has on order, but the trade in is understood to be at least a year away. JAL has an option on one turbojet-powered DC-8.**

► Aeroflot, the Soviet airline, is expanding its vacation travel flights this year, with particular concentration in the Caucasus-Black Sea resort areas. Adler Airport, a departure point for much of the area, will have 20 turboprop Il-18 and An-10 daily round trips during the summer from widely scattered points in Russia.

► **Western Air Lines and the International Assn. of Machinists have signed a labor contract covering maintenance personnel from Apr. 1, 1961 to Mar. 31, 1963 and providing two-step pay increases ranging from $28 to $40 a month.**

► Sud Aviation plans to manufacture five Mark VII Caravelles for speculation. Powered by General Electric turbofan engines, the Mark VII is expected to be certificated this month, with first deliveries promised next February.

► **San Francisco & Oakland Helicopter Airlines began its first daily service last week linking airports of the two cities with downtown heliports. Two Sikorsky S-62 helicopters are providing a frequency pattern of 30 daily flights between 6:30 a.m. and 10:30 p.m. Present schedules are to be doubled June 15.**

SHORTLINES

► **Allegheny Airlines** has instituted a 10% discount for cargo shipments between 500 and 1,000 lb. and a 20% discount for shipments over 1,000 lb. The airline also raised the maximum weight limit per cargo piece from 150 to 200 lb. to expand cargo services.

► **British West Indian Airways** reports it carried 226,688 passengers 110.7 million revenue passenger miles during 1960, increases of 5% and 14% respectively over 1959.

► **Delta Air Lines** has Civil Aeronautics Board permission to suspend service between Chicago and Ft. Lauderdale, Fla., until December after determining that May-November seasonally low traffic would not meet the breakeven need for the route.

► **Federal Aviation Agency** has launched Project Pipeline, a one-year program which includes a study of agency supply practices and development of future supply services keyed to demand.

► **Flying Tiger Line** reports $20.5 million operating revenues and a net income of $42,856 for the nine months ending Mar. 31, 1961, compared with $19.5 million operating revenues and a net loss of $623,688 for the same period last year.

► **KLM Royal Dutch Airlines** has begun DC-8 service from New York to Shannon, Ireland, with two weekly flights and to Glasgow, Scotland, with five flights per week.

► **Pacific Air Lines** reports an operating profit of $113,135 for the first quarter of 1961.

► **Pakistan International Airlines** has received a foreign air carrier permit authorizing service between Karachi, Pakistan, and New York via points in England, West Germany, Switzerland, Italy, Turkey, and alternate points in Lebanon, Egypt, Iran and Saudi Arabia.

► **Panagra** has Civil Aeronautics Board permission to continue suspension of service to Oruro, Concepcion, San Ignacio, San Jose, Robore, and Puerto Suarez, Bolivia until June 1, 1963. Panagra has disposed of its DC-3s, the only feasible aircraft to serve those points.

► **Viasa,** newly-formed Venezuelan airline, has received President Kennedy's approval to take over the routes in the foreign air carrier permits of Venezuela's LAV and Avensa.

PROGRESS IN MICROWAVE'S

New General Electric VTM's and TWT's . . .

ADVANCE S- AND X-BAND TRANSMITTER CAPABILITIES

Provide Higher Power in Lighter, Smaller Tubes

Four new General Electric power tubes—two voltage-tunable magnetrons and two traveling-wave tubes—have been designed to advance transmitter capabilities in S- and X-bands. All provide higher power in smaller, lighter, more compact packages for missile and airborne transmitter applications.

HIGH EFFICIENCY, LIGHT WEIGHT VTM's

Designed primarily for space applications, the Z-5428 voltage-tunable magnetron achieves an efficiency of 35 percent in a tube weighing only 4.5 pounds. Moreover, it operates under severe shock and vibration conditions with only radiation cooling. Tests show the Z-5428 meets shock requirements of 40 G's for 11 milliseconds and vibration requirements of 5 to 25 cps at one quarter-inch double amplitude; and from 25 to 2000 cycles at 10 G's.

Equally efficient and compact, the Z-5424 provides high power (50 W min.) in an exceptionally light (4.5 pounds) VTM. And like the Z-5428, it is a complete r-f power package requiring only input and r-f output power connections.

Both VTM's can be linearally voltage-tuned without mechanical adjustment.

HIGH-POWER, COMPACT TWT's

The two new high-power traveling-wave tubes are designed to operate in series, one as the driver and one as the final amplifier in a pulsed high-power chain for X-band radar applications. They are compact, of metal-ceramic construction, and incorporate an advanced focusing system utilizing periodic permanent magnets requiring no temperature stabilization. The Z-3090 driver tube weighs only 15 pounds while the Z-3091 amplifier tube weighs 42 pounds with electrical connectors. Both tubes are ruggedized for airborne applications and can be mounted in any position.

These TWT's, as well as the new VTM's, are now available in sample quantities. Delivery in 90 to 120 days.

265-06

FREQUENCY RANGES AVAILABLE*

VTM's OSCILLATOR SERVICE

Frequency (KMC)	P_0 (Min. CW)
2.2 – 2.3	10 W
2.5 – 3.5	10 W
2.9 – 3.2	50 W
5.17 – 5.42	10 W

TWT's AMPLIFIER SERVICE

Frequency (KMC)	P_0 (Min. Peak)
5.4 – 5.9	25 KW
8.5 – 9.6	5 KW
8.5 – 9.6	50 KW
8.5 – 9.6	250 KW

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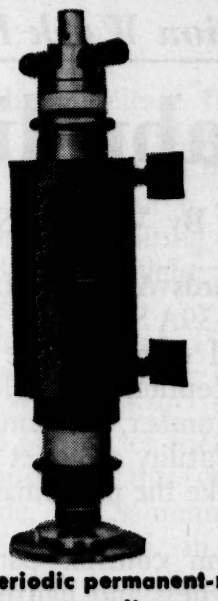

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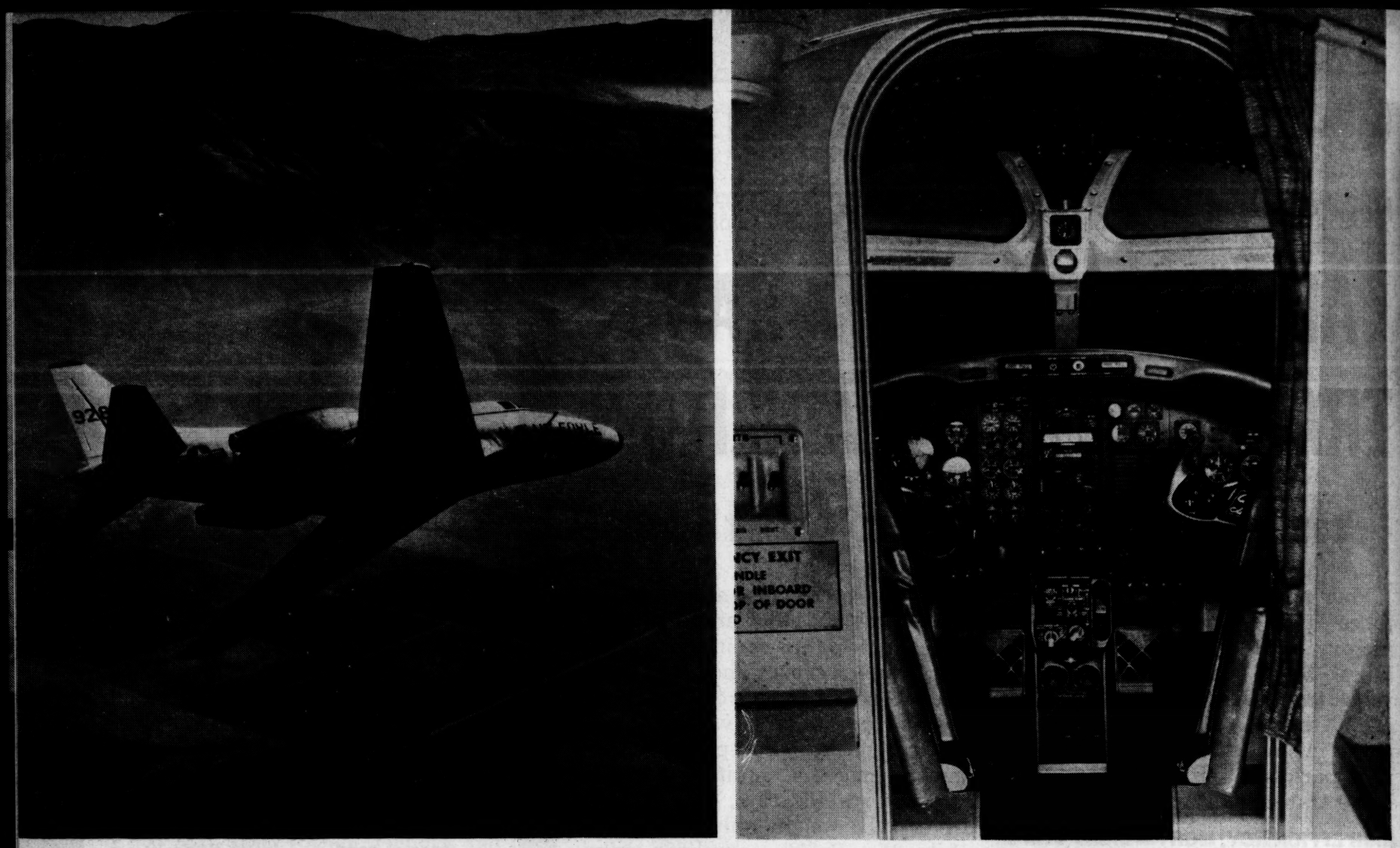


T-39 SABRELINER shown during test flight over Palmdale, Calif. Plane can be flown by one pilot, so all flight controls and instruments are accessible from left seat. Copilot's panel is fully instrumented for navigational and instrument proficiency training.

Aviation Week Pilot Report:

Sabreliner Shows Fighter-Like Handling

By William S. Reed

Edwards AFB, Calif.—North American's T-39A Sabreliner is comparable in size and weight to the F-86 and, with the exception of a lower maximum Mach number, performance of the new trainer/utility cargo jet transport is very much like the performance of the Sabre fighter.

Aileron control, particularly in responsiveness and lightness of the force gradient, is definitely in the same category as the F-86.

Outstanding Features

During a recent 2 hr. 40 min. flight by this AVIATION WEEK pilot, aside from the aforementioned fighter-like handling and performance characteristics, these additional features left an impression:

• **Ground handling** is simplified by the inclusion of hydraulic nose wheel steering operated in conjunction with the rudder pedals. A button on the control wheel engages the hydraulic steering. It incorporates a holding relay, a feature test pilots have been urging for several years, whereby one push engages the system, a second push disengages it. Free action of the pilot's hands thus is assured during taxi operations because the button does not have to be held down.

• **Emergency descent** from maximum operating altitude is accomplished with great rapidity. From a cruising altitude of 44,500 ft., descent was made to 15,000 ft. in 2 min. 46 sec. with idle power, speed brake out. A floor angle of approximately 30 deg. is achieved during descent at normal operating Mach, V_{NO}.

• **Emergency procedures** and systems operations are simple because the aircraft uses state-of-the-art developments. Electrical system uses d.c. generators on both engines with inverters for a.c. power. Nickel-cadmium batteries are used for ground start and emergency d.c. power and to operate flaps and trim. Control system is all-mechanical, therefore not affected by hydraulic or electric failure. Landing gear extends by gravity and aerodynamic pressure with accumulator pressure available for speed brake extension.

A strong, gusty surface wind prevailed at the time of AVIATION WEEK's flight in the number five T-39A with Air Force project pilot Capt. T. D. Benefield. A quartering headwind on the ground measuring 18-20 kt. with gusts to 30 kt. threatened to cancel the flight but by cutting the preflight discussion short, the aircraft was put into the air before the winds forced cancellation.

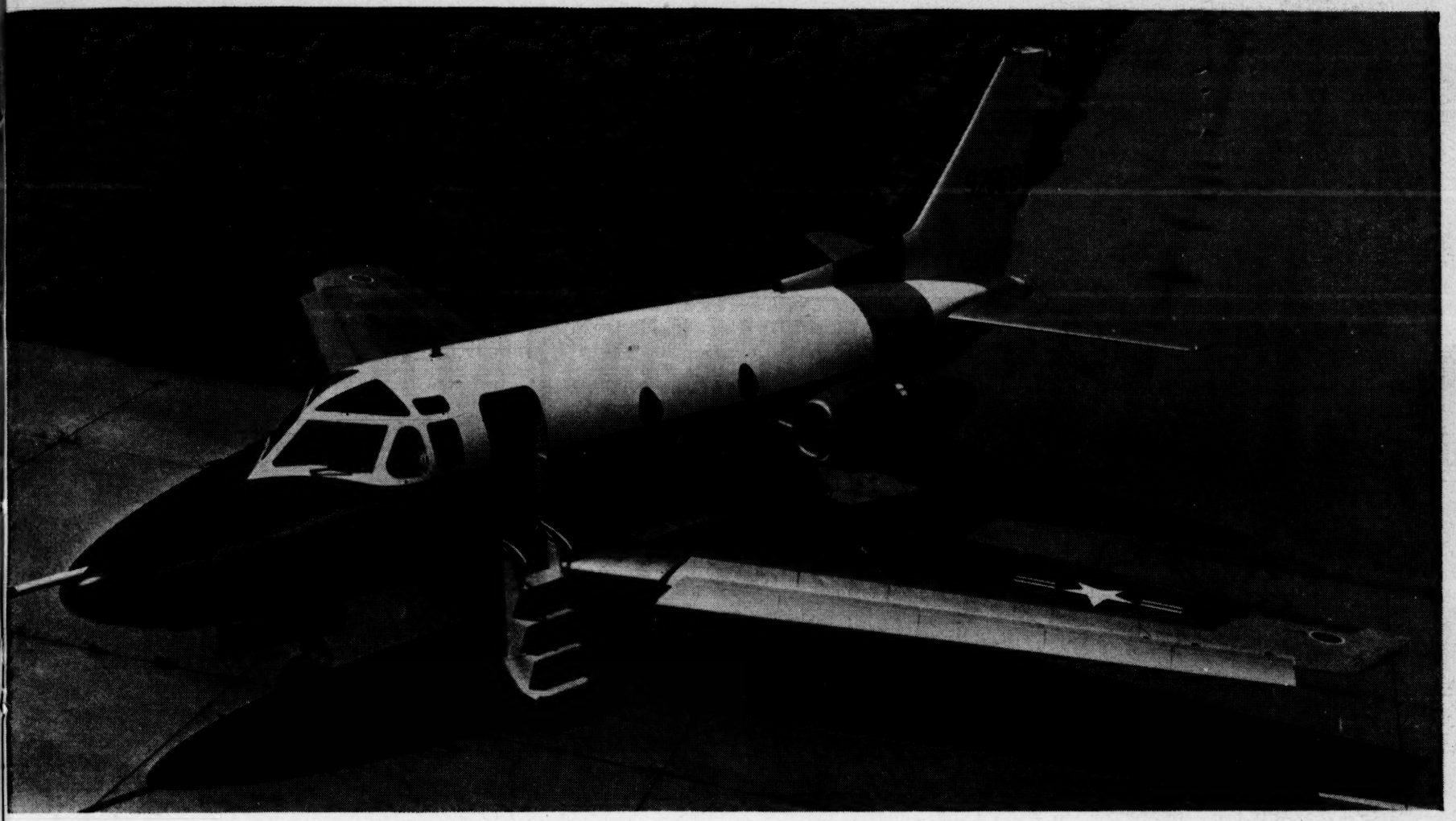
T-39 Cockpit

The Sabreliner cockpit is laid out for single pilot operation. All instruments and controls necessary for flight are located convenient to the pilot in the left seat. Flight instruments are duplicated in the right seat for pilot training.

Starting engines on the Sabreliner is a simple matter: starter button is depressed, which accelerates the engine to 10% rpm. through the starter-generator. Either internal or external power may be used. At 10%, throttle is opened to idle, energizing the ignition and commencing fuel flow.

Lightoff occurs, the button pops out at about 33% rpm. and the engine accelerates to an idle speed of about 42%. Procedure is repeated for the other engine.

A slight increase in power is necessary to get the aircraft rolling, after which idle power is sufficient to maintain a nominal taxi speed. Despite the crosswind, the narrow tread of the main gear presented no problem during ground operation and the aircraft heeled less than anticipated. Visibility is good, brake control positive



CURRENTLY being flown with four passenger seats, tests are under way to prove out installation of six passenger seats. Cabin maintains 8,000-ft. pressure altitude to 45,000 ft., and 8.8 psi. differential above that altitude. Teardrop-shaped windows limit passenger visibility.

Performance

and nose wheel steering provides precise control.

Takeoff gross weight of the Sabreliner for this flight was 17,100 lb., including 7,000 lb. of fuel and six persons. Maximum permissible gross weight is 17,760 lb., including provision for two extra seats in the cabin. Plan is for the aircraft to weigh 8,800 lb. empty, contain 7,000 lb. of fuel and carry eight persons or 1,500 lb. of cargo for 1,500 mi.

Determination of engine setting to produce military thrust is accomplished by a rather awkward procedure involving exhaust total pressure, P_{t5}. Since the engine fuel control does not compensate for inlet temperature, the pilot must determine ambient temperature and pressure and then consult a chart or computer to determine P_{t5}, expressed in inches of mercury. Exceeding the proper P_{t5} could result in exceeding the pressure limits on the compressor or turbine and might contribute to shortened engine life or possible failure. The same computation must be conducted at each 5,000-ft. interval on climbout and is a considerable burden on the pilot, especially during instrument departure. This arrangement is a matter of economy, the Air Force says; present exhaust pressure ratio measuring devices are considered too expensive. Discussions are under way regarding installation of a more suitable thrust measuring device which will require less pilot attention. P_{t5} on this particular day was 57½ in. Hg.

Directional Control

Directional control, even in the existing strong crosswind at Edwards, presented no problem on takeoff. Control is maintained by nose wheel steering until rudder effectiveness is obtained at 60 kt. Rotation is started at 105 kt. and the T-39 lifted off at about 120 kt. The same nose-light tendency experienced in F-86s is noted in the T-39 as the aircraft comes unstuck and leaves ground effect. Slight relieving of back pressure on the elevator is necessary as the elevator leaves the downwash produced by ground effect. Landing gear is retracted when definitely airborne with flap retraction accomplished before airspeed reaches 160 kt.

The aircraft accelerated rapidly to best climb airspeed of about 260 kt. and passed through 5,000 ft., indicating a rate of climb of about 3,500 fpm.

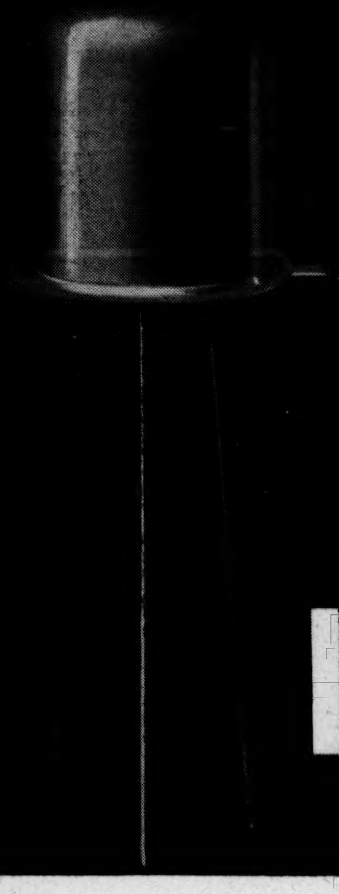
Over-the-nose visibility suffers somewhat in the climb as it does in most aircraft but not to a critical extent. Visibility is enhanced considerably by the "eyebrow" windows which allow upward and sideward visibility especially in turns.

The T-39 passed through 20,000 ft. 6½ min. after brake release from Edwards, climbed through 30,000 ft. in 11 min. and reached 35,000 ft. in 15½ min. from takeoff. From a climbing Mach number of .62, limiting Mach of .76 was reached in level flight one min. after leveling off.

Setting up for cruise at 35,000 ft., fuel flow registered 1,750 lb./hr., rpm. 97%, and fuel quantity indicators showed about 5,600 lb. of fuel remaining. By continuing at this cruise setting and altitude, the Sabreliner could have flown 1,150 naut. mi., in addition to the 90 mi. covered in the climb, or 1,240 mi. with a 30 min. reserve at altitude. By climbing immediately to an initial altitude of 41,000 ft. and cruising-climbing to 45,000 ft., 1,500 naut. mi. could have been covered in 3 hr. 30 min. with a 40 min. reserve.

Indicated airspeed was about 255 kt. at this altitude, providing an adequate margin of maneuvering speed until the onset of stall buffeting. Control in all three axes was positive and stable with a little more than a normal amount of elevator force required to maintain altitude in turns. A slightly high elevator force gradient in all maneuvers is required in the T-39.

Later, the aircraft was climbed to 45,000 ft. and here the indicated speed dropped to about 200 kt. at Mach .76. The aerodynamically-operated leading edge slats began to extend whenever the bank angle approached more than



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30 deg. but their extension is equal on both wings. Considering the altitude, maneuvering margin is very high in this aircraft. Cabin altitude was maintained automatically at 8,000 ft. to 45,000 ft., thereafter an 8.8 psi. differential is maintained. Heating and pressurization was satisfactory and the engine noise level was not excessive. Considerable noise is generated by the air conditioning system in this model but this has been reduced to a much lower level in models now coming off the line, North American says.

Simulated Emergency

Emergency descent was executed from 45,000 ft. while cruising at Mach .76. Throttles were retarded to idle, speed brake extended and airspeed held at .76. Floor angle becomes rather steep (about 30 deg.) and descent to 15,000 ft. took 2 min. 46 sec. Although a large-area speed brake is located beneath the fuselage, in a manner similar to the F-100 series, little trim change accompanies its deployment and buffeting is minimal.

High "Q" out to limiting operating Mach of .76 or an IAS of 400 kt. was tried with satisfactory handling qualities noted. Trim change with increasing speed was nominal, indicating positive speed stability until the M_{NO} is approached. At this point, a mild tuck-under starts to occur but is barely perceptible. Nose-down pitching becomes greater as the Mach number approaches .82, Benefield says, requiring considerable trim change above this speed, hence the fairly low Mach number to which the aircraft will be limited. Never exceed speed, M_{NE}, is .85 and above this, indications are that the trim change is great.

Stalls were conducted in the clean and landing configuration below 15,000 ft., the maximum altitude for stalling at the present time. Stall restriction probably will be raised to 25,000 ft. soon since present tests indicate some progress in the post-stall engine flameout problem. North American and Pratt & Whitney both are working on the problem of post-stall engine flameout at altitude caused by a reverse air flow at the inlet resulting in richened fuel mixture as revealed by tuft studies. Inlet spikes have been tried as well as various inlet geometry changes. Inlet changes have resulted in raising the stall altitude but have not completely licked the problem.

Question as to whether the aircraft should be stalled above 25,000 ft. is debatable. Air Force says the aircraft must have this capability in order to prevent some hapless pilot from losing both engines if he inadvertently stalls trying to top a thunderhead.

Stall characteristics are very good in both clean and landing configurations.

T-39 Basic Data

Wing area	342.05 sq. ft.
Aileron	16.42 sq. ft.
Wing flap	40.26 sq. ft.
Wing slats	36.34 sq. ft.
Wing sweep	28 deg.
Horizontal tail	77.00 sq. ft.
Vertical tail	41.58 sq. ft.
Fuselage size	
Height	78.00 in.
Width	70.00 in.
Design landing weight	
Normal	13,000 lb. at 10 fps.
Maximum	17,760 lb. at 6 fps.
Maneuver load factor (symmetrical)	V_e
Basic mission (g)	+4.0
	−1.0
Extended range (g)	+2.5
	−1.0
Powerplant	(2) P&W J60-P-3
Weight (dry)	479 lb.
Ratings	
Military (SL) 30 min.	3,000 lb.
Normal, (92%) continuous	2,400 lb.
Gross weight	
Normal range	16,701 lb.
Extended range	17,760 lb.
Fuel	
Normal range	893 gal.
Extended range	1,056 gal.

Clean, the aircraft supplies ample warning of impending stall. Buffet margin is about 15 kt. with intensity increasing as the stall approaches. Control, particularly aileron, remains good through the post-stall region. At a weight of 13,000 lb. the aircraft paid-off at about 95 kt. Lowering the flaps and gear reduced the stalling speed to 90 kt. with control remaining equally good. Slats, over which the pilot exercises no control, start to extend at about 180 kt. at 1g. Extension is even and no wing roll occurs.

Engine accelerations from idle to full power at 13,000 ft. took 4 sec., an excellent response time. Also at 13,000 ft., one engine was held at idle while the remaining one was advanced to maximum continuous power, 97% rpm. Very little rudder requiring only moderate force was needed to hold straight and level. The aircraft accelerated from 130 kt. to 210 kt. very handily, bearing out the single engine performance statistics which indicate that the T-39 could climb from sea level to 20,000 ft. in 30 min. on one engine. Single engine service ceiling is listed as 30,000 ft.

Landing pattern was entered at about 160 kt. with the speed brake extended or retracted as conditions dictated. Speed brake may be left down throughout the pattern because it has very little effect on stalling speed. Normally it is retracted once the downwind leg speed of 145 to 150 kt. is reached and the gear lowered. Flaps are extended at 140 kt. with airspeed reduced to 130 on base leg. Considerable nose-down trim change is experienced with flap extension and North American installed a pitch trim compensator which automatically adjusted elevator position as the flaps lowered, making trim change less apparent to the pilot. Air Force, however, elected to eliminate this feature and trim now must be applied to the elevator simultaneous with flap actuation. This is not difficult and is a condition extant in many accepted aircraft.

Once the pilot knows the trim change is coming, he can apply trim as flaps are actuated. Rate of trim change is about equal to the rate at which the stabilizer is moved by the trim system and holding force on the control yoke is virtually eliminated once the trim change is anticipated.

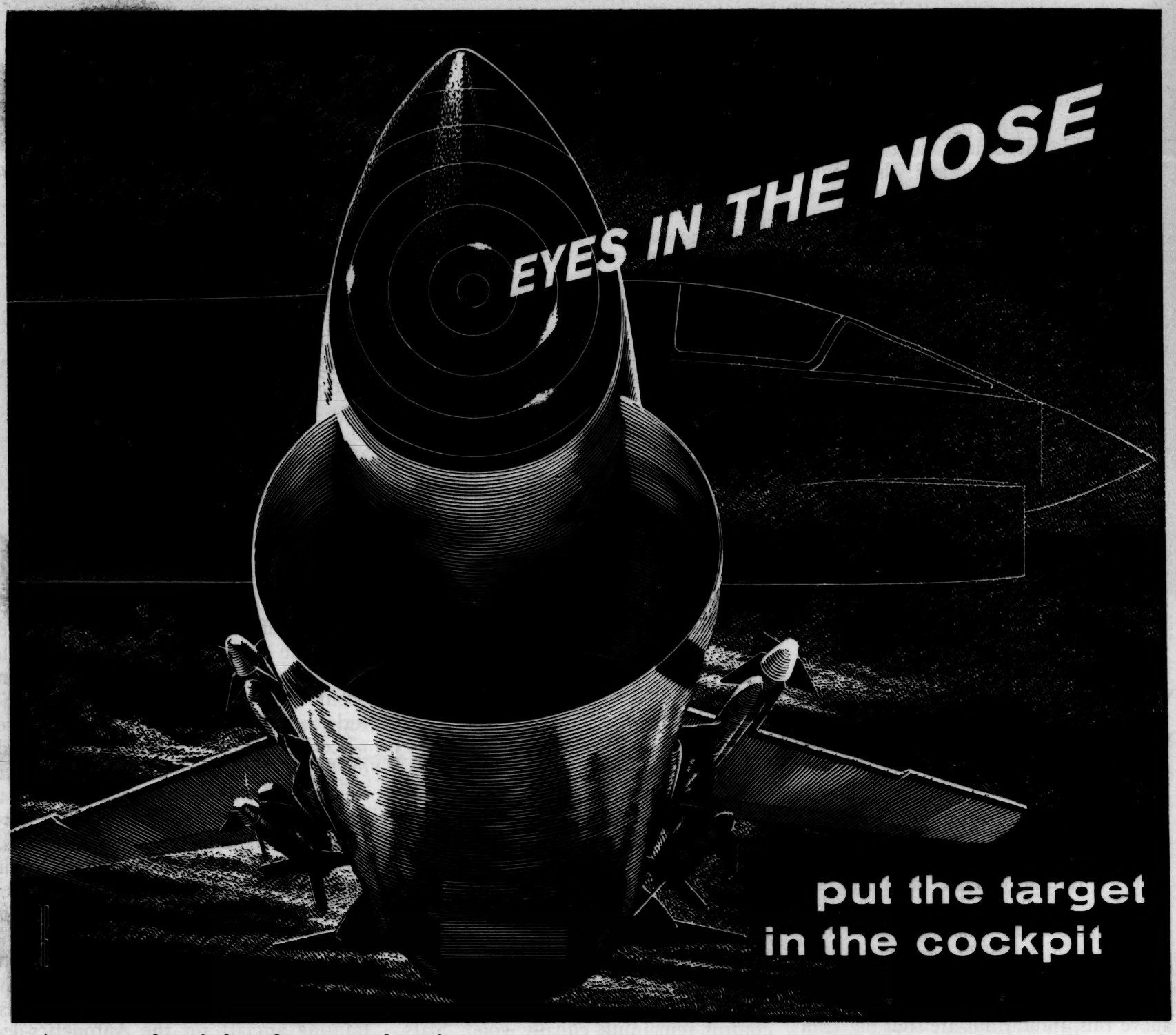
Approach Procedure

Approach is set up at 115 kt. and a power-off flareout can be conducted since the aircraft does not have high sink rate characteristics. Touchdown occurs at 95-100 kt. in a nose high attitude not appreciated until the nose wheel is lowered. The nose can be held off but it is generally allowed to contact the ground shortly after the main gear touches for improved visibility and better ground handling. As speed dissipates, nose wheel steering is engaged. With moderate braking, the Sabreliner was brought to a stop in less than 3,000 ft.

A total of 94 Sabreliners has been ordered by the Air Force, six of which are the T-39B configuration used as training aircraft for the Autonetics-developed North American Search and Ranging Radar (NASARR). Four of the B models have been delivered to Nellis AFB, Nev., where they are being used to train Republic F-105D pilots in operation of the NASARR system (AW Apr. 17, p. 88). The remaining 88 Sabreliners will be in the A configuration flown by AVIATION WEEK for this report.

So far, no definite follow-on orders have been placed for the aircraft although indications are that the Air Force will increase the number of NASARR-equipped Bs as the training program develops. Essentially the same system used in the F-105 also is installed in the Boeing B-52, indicating further need for NASARR training.

Commercial certification of the Sabreliner is being carried out by North American with an eye to offering the aircraft as an executive transport. The company's plans in the commercial field are not firm and they say no orders have been taken for private delivery. Price of the Sabreliner, without avionics, is about $750,000.



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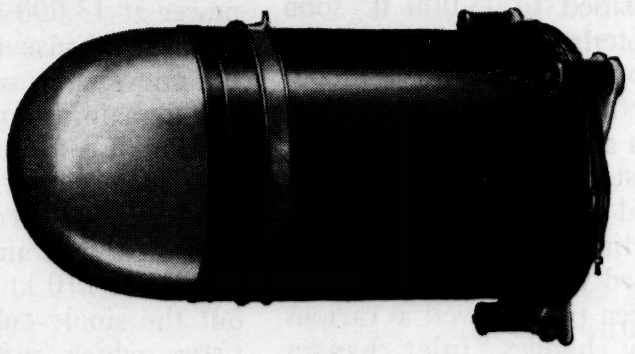

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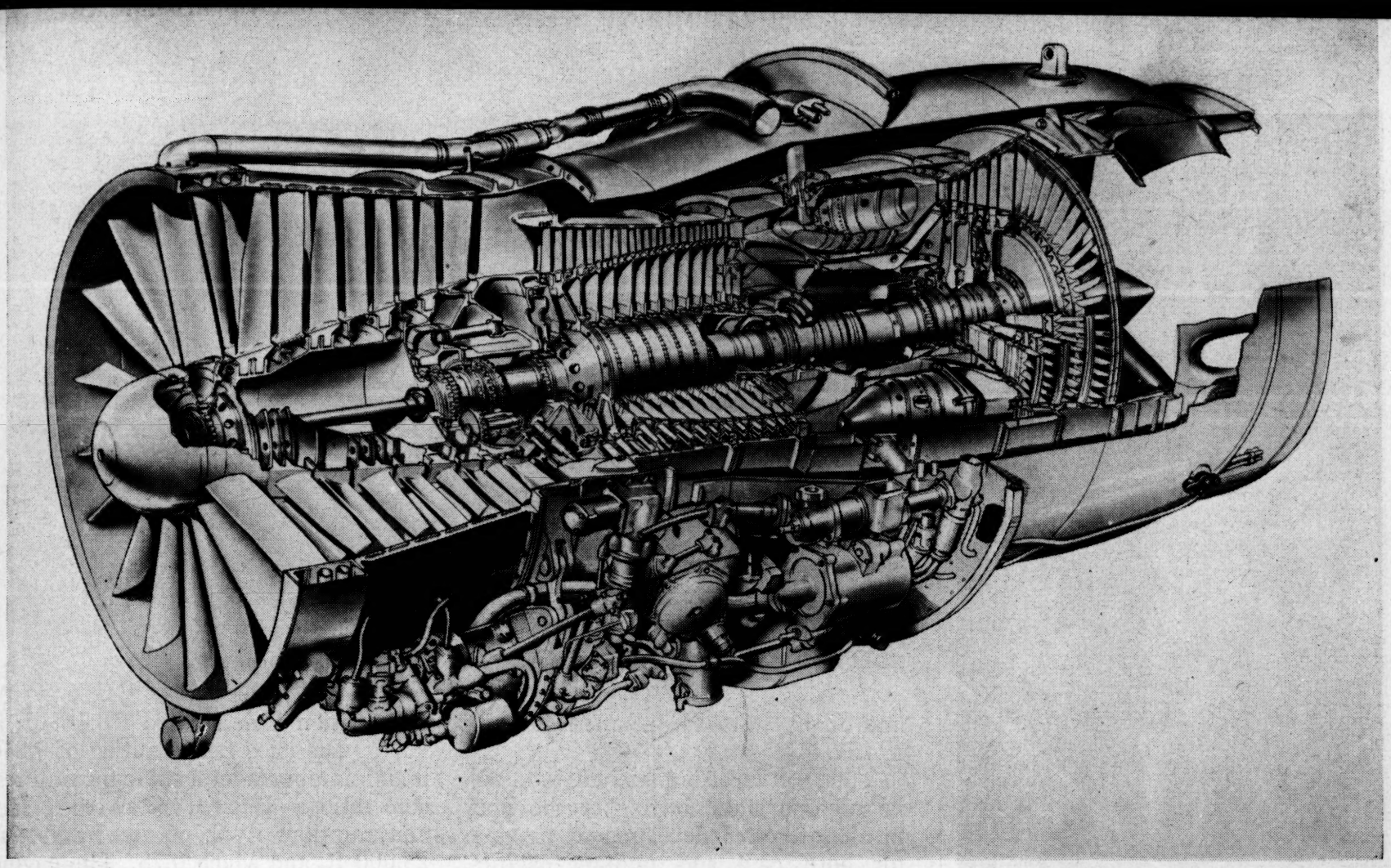


SPEY CUTAWAY shows four-stage low-pressure compressor and variable stator stage just upstream of 12-stage high-pressure compressor. Ten flame tubes are in the cannular combustor. Five Spey engines are undergoing static tests at sea-level conditions.

Spey Features Mechanical Improvements

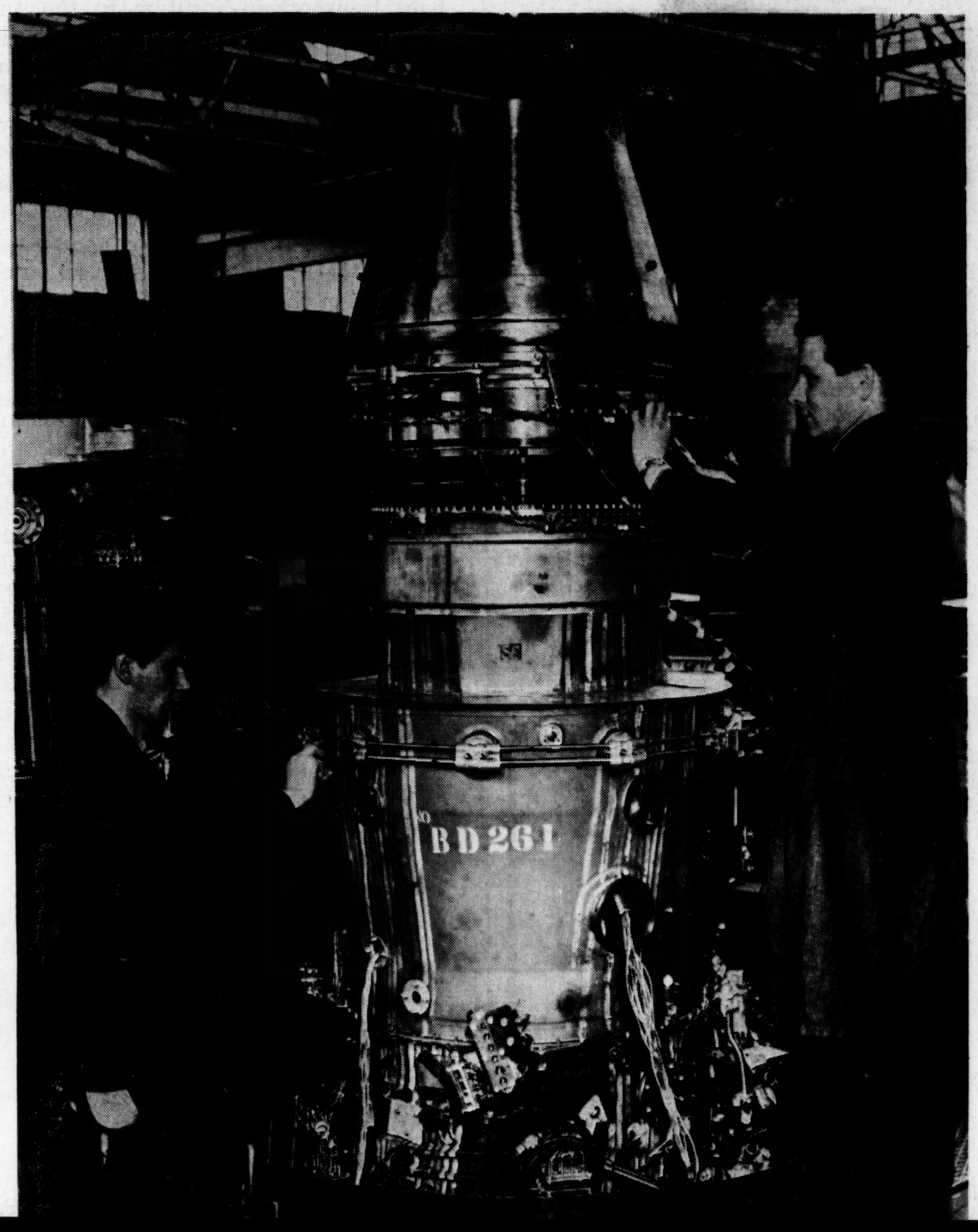
London—First details on the design of the Rolls-Royce Spey (RB.163) bypass engine series show new mechanical features in four areas:

- **Fuel control system** is all-mechanical to improve reliability. Earlier units used pressure-response systems with electro-mechanical linkages.
- **Low-pressure compressor** is shell construction instead of the solid disk-plus-blade design usually employed.
- **High-pressure compressor** has variable stator stage at the inlet.
- **Bypass air-engine exhaust mixer** is a new approach featuring individual inlets leading from the bypass shroud into the exhaust stream to get a lower exhaust velocity from improved mixing.

Current Testing

Five Spey engines are currently running in static tests at sea-level conditions; altitude testing is scheduled to start soon. A complete Spey powerplant is scheduled for current static testing in a pod with thrust reverser and noise suppressor built to production standards of the de Havilland Trident three-jet short-range transport.

Flight tests will start in August with two Speys mounted in an Avro Vulcan testbed, and Trident ground



MINUS its bypass duct, Spey engine (right) is at an advanced stage of assembly in the experimental shop.

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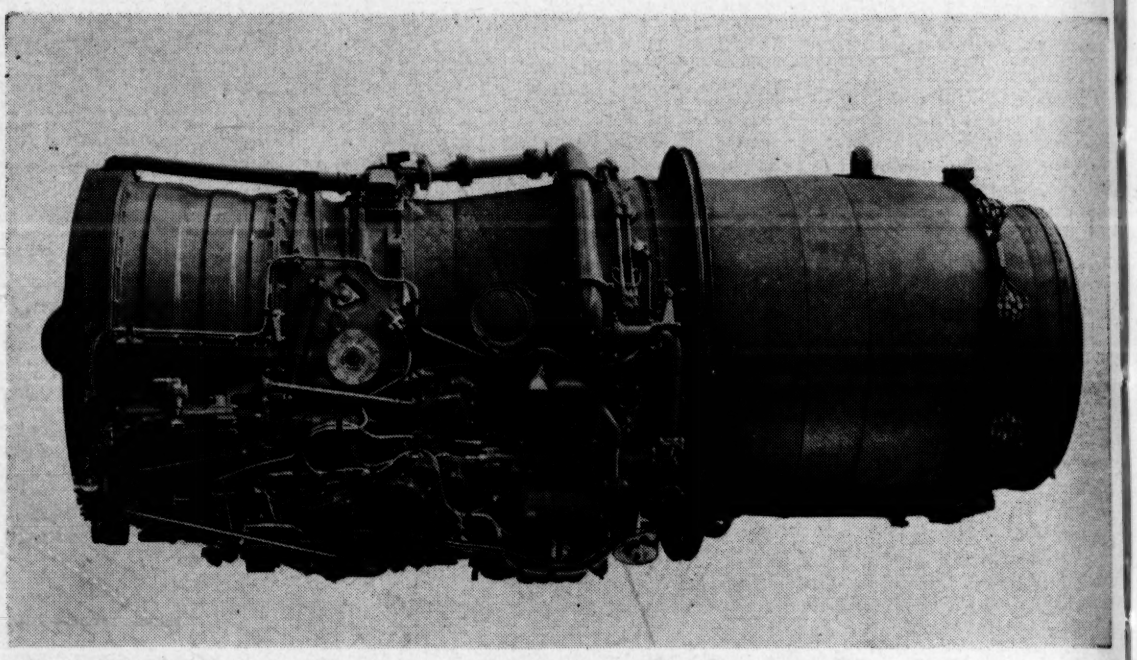


ROLLS-ROYCE Spey bypass engine is 110 in. long, 37 in. in diameter.

and flight tests are planned for this winter.

Total of 14 complete engines will be used in static testing of the Spey in an integrated development program for both civil and military engines. Additional engines will be used in flight and endurance test work.

The Spey carries a current guaranteed static thrust rating of 9,850 lb. The engine has been selected for the British Aircraft Corp. BAC 111 short-haul transport in addition to the Trident. The military contract is for development and construction of a number of prototype engines, presumably scheduled for the Blackburn NA.39 low-level strike aircraft for the Royal Navy.

Spey design drew heavily on the company's experience with the RB.141 bypass engine planned for the original, larger DH Trident. The RB.141, rated at a design thrust of 15,000 lb., was in turn based on the Conway; experience on that powerplant is also part of the Spey.

Nine development engines were produced under the RB.141 program, and have been accumulating test time since they first ran in November, 1959. Rolls says that development experience on the RB.141 has been directly applicable, almost in its entirety, to the Spey work.

One example of this: RB.141 tests included simulation of the compressor-inlet flow conditions using the Trident center-engine air intake system. With this background, Rolls-Royce engineers could go directly to tests of the Spey fitted with complete center duct and inlet cowl of the Trident.

Current engine time on all five development Spey engines totals about 250 hr., of which about half is on one engine used for endurance running, and which has completed a 60-hr. test.

Design work on the Spey began in September, 1959, and the first engine ran at the end of December, 1960. Current version is designated RB.163/1; it has a guaranteed takeoff rating of 9,850 lb. minimum sea-level static thrust. Pressure ratio is 17:1. Typical cruise fuel consumption is 0.766 lb./hr./lb. at 25,000 ft. and Mach 0.78. The engine weighs 2,200 lb. dry, is 110 in. long from intake face to exhaust cone flange, and has a maximum diameter of 37 in. Production engines are scheduled for late next year.

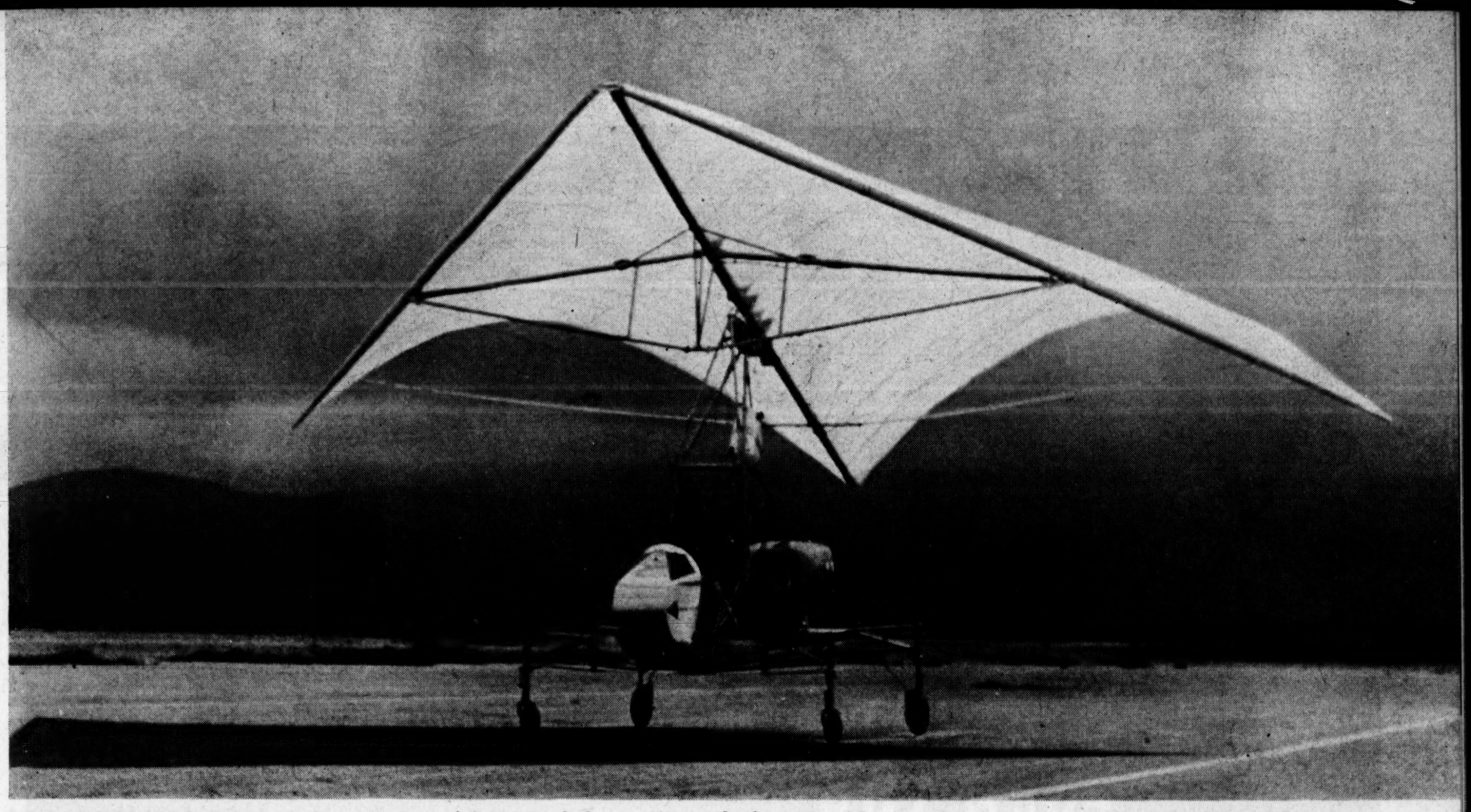
Next in the series is the RB.163/2, which will be rated at 10,410 lb. sea-level static thrust due to minor refinements in the design. It will enter production in 1963.

Spey, RB.141 and Conway all use the basic Rolls-Royce bypass concept, in which all of the intake air passes through the low-pressure compressor before dividing to pass through or around the rest of the engine. In the case of the Spey, the flow ratio is unity; that is, equal parts of the swallowed air pass through and around the engine.

Rolls claims this ratio is an optimum for its bypass engines. The company cites two advantages of its engine geometry over that of turbofans—a nomenclature which Rolls rejects:

- **Single air inlet and nozzle** for both flows minimize installation weight and simplify design of both reverser and silencer.
- **Premixing hot and cold flows** before expansion through a single nozzle improves propulsive efficiency about 5% over systems with separate nozzles.

Rolls says optimum bypass ratio range is between 0.7 and one, at cruise cycle temperature of 1,150K (approximately 1,600F) with the air-cooled turbine blading which characterizes the company's twin-spool bypass and turboprop engines. This range is not accepted by all engine manufacturers as optimum; their literature shows a wider span of numbers depending on the company and the engine application envisaged.



RYAN'S ROGALLO WING airplane consists of four-wheeled open frame body with high central pylon hanging beneath ribless delta wing.

Rogallo Wing Studied for Combat Mission

By Russell Hawkes

San Diego, Calif.—Ryan Aeronautical Co. has begun flight tests of an experimental Rogallo wing (AW Sept. 19, 1960, p. 57) airplane here in a program jointly financed by the company and the Army.

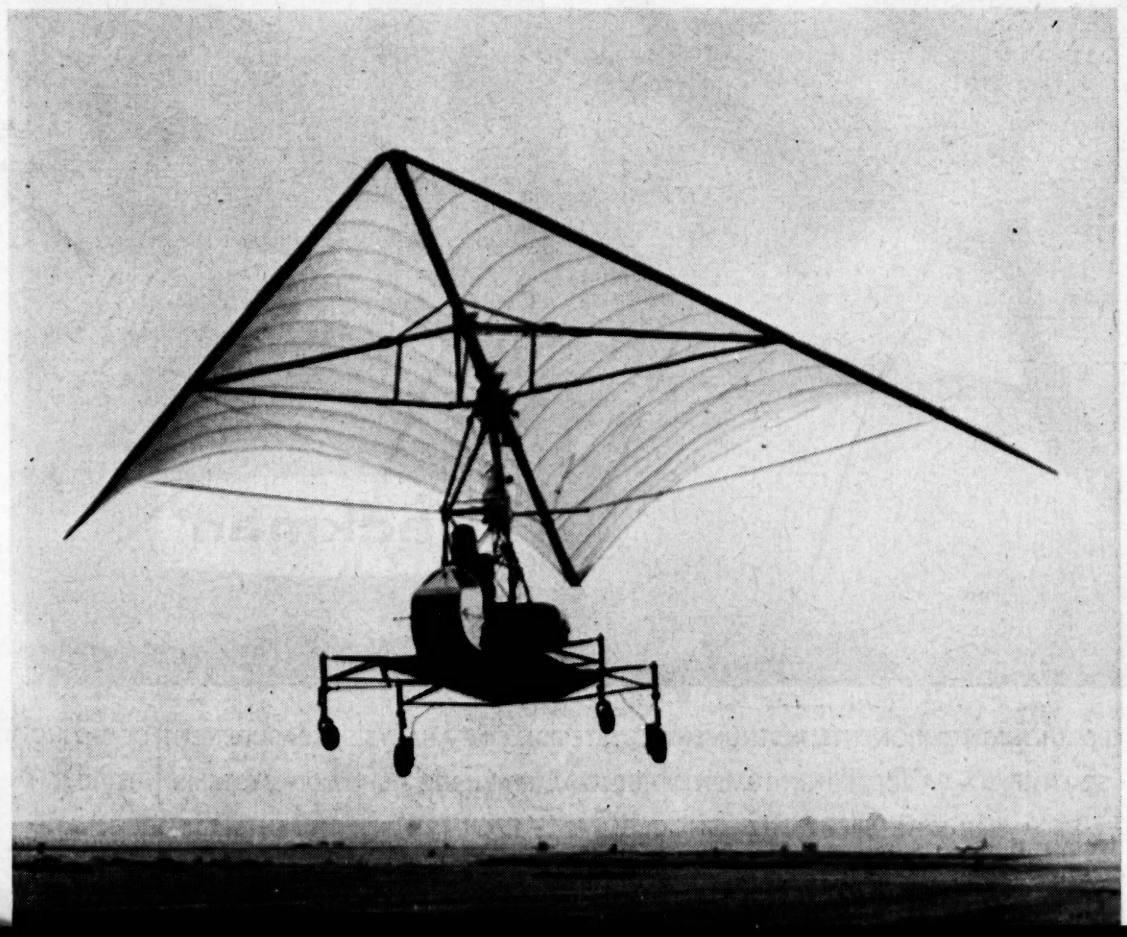
At present, Army's participation consists of a $100,000 contract from Transportation Research Command to pay for part of the test program now beginning. The design and manufacture of the testbed were funded by Ryan. Army aviation authorities hope the collapsible airfoil vehicle can be developed into a light, inexpensive, easy-to-operate aircraft for numerous battlefield roles.

At the other end of the performance spectrum, National Aeronautics and Space Administration has awarded Ryan a $150,000 contract to study the feasibility of equipping the Saturn S-1 space booster with a Rogallo wing to make it recoverable. It also has been proposed as a lift system for re-entry vehicles.

The concept was invented by Francis M. Rogallo of NASA and has been investigated in wind tunnel and unmanned scale model studies at NASA's Langley Research Center. Ryan has named its version "Flex Wing" and conducted further model tests before building the manned testbed. Ryan project engineer Cecil Craigo told AVIATION WEEK that much of the data used in the design of the experimental Flex Wing airplane was obtained about 80 years ago in pioneer glider flights by Otto Lillienthal in Germany.

Craigo said the testbed aircraft has

WING FABRIC is Mylar bonded to nylon. Plane is powered by a 100-hp. Continental pusher engine (AW May 29, p. 30).



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been designed to give maximum flexibility and scope to the experimental program and not to demonstrate performance levels for any particular application.

The airplane has a gross weight of 1,100 lb. without flight test instrumentation and 1,400 lb. with it. It consists of a four-wheeled open-frame body with a high central pylon hanging beneath the ribless fabric delta wing. It is powered by a 100-hp. Continental engine mounted as a pusher at the aft end of the fuselage.

The wing fabric is Mylar bonded to nylon and was made by the Lowell North Sail Co. More than 20 other materials are still being investigated for possible use. When at rest, the fabric hangs loosely between the longitudinal "keel" and a pair of tubular leading edges flexibly joined at the front end of the keel. Like a boat sail, it only assumes aerodynamic power when it has been inflated by the flow of air.

Primary wing members are each 28-ft. long and the area of the fully deployed wing is 555 sq. ft. A truss-type spreader just forward of the wing-fuselage link holds the wing members fixed at a leading edge sweep-back angle of 45 deg., calculated to give the best ratio of lift to drag. This sweep angle gives the wing a span of 39.4 ft. The keel and leading edges are made of aluminum alloy to aircraft construction standards.

Craigo says the spreader structure is not an essential part of a Flex Wing airplane and an operational version might not have it.

Spreader's Purpose

The chief reason for it on the testbed is to give the airfoil a constant configuration. Uncontrolled and unmeasured changes in its shape would make test data meaningless, and continuous correlated measurement of all the variables thus liberated is probably impractical. Redesign of the spreader bar to get controlled variations in the shape of the collapsible wing is possible but Craigo said Ryan is not far enough into the program to make such plans. Since it is there, the spreader bar is also used to carry part of the flight loads from the leading edges to the keel of the testbed wing but other ways of doing this may be used if Flex Wing aircraft reach operational status.

Ryan's first interests in the Flex Wing test program are to demonstrate feasibility and to investigate the operation of the concept at very low wing loadings—about 2 psf. In approximately 30 test flights from Brown Field, Otay Mesa, the experimental Flex Wing has not yet been taken out of the traffic pattern or to altitudes higher than 500 ft. However, Craigo says that the testbed should be capable of an altitude of 20,000 ft. later in the program and perhaps higher if an engine designed for high altitudes is installed.

While a total of nearly 70 flight and ground tests have been made in the program, Ryan is not yet producing much new quantitative data. First tests of a radical vehicle must be limited to showing that it can get off the ground and remain under control. Ryan has now proved this and is beginning more elaborate and intensive investigations.

Control System

Control system of the Flex Wing functions without benefit of conventional hinged surfaces and flaps by altering the balance of the aircraft. The body swings from hinges between the pylon and the wing keel. By pushing, pulling or turning his control yoke, the pilot moves the fuselage forward, backward or sideward relative to the wing above him, thereby moving the horizontal position of the center of gravity relative to that of the center of pressure on the wing. This causes the wing to tilt toward the new position of the center of gravity.

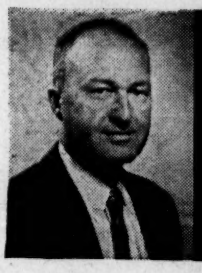
The principle is the same used in the control of hang gliders by Otto Lilienthal and other experimenters in the last century. The strength of the pilot's arms was used to lever the mass of his body laterally or longitudinally to change the attitude of the glider by altering its balance.

Craigo defends the mass-shifting technique of flight control as superior or potentially superior to the more conventional methods of using movable surfaces to change air flow patterns so as to move the aerodynamic center of pressure with respect to the fixed center of gravity. Mass-shifting affects the relative position of the two centers directly and there is no lag while the pattern of air circulation rearranges itself, he said.

The testbed aircraft is highly stable because of the pendulum effect produced by locating the wing on top of a pylon far above the airplane's center of gravity. Craigo said pendulum oscillations of the airplane are well damped and converge quickly. Directional stability is so great that Ryan engineers have given the testbed nothing equivalent to a rudder. When the pilot banks the airplane, the directional stabilizing force keeps the nose coming around in a balanced turn.

A parallelogram linkage between the wing keel and the top of the body pylon can be adjusted from the cockpit to produce some translational movement between the wing and the body.

Nylon cords or strapping between the leading edges and the keel keep the wing fabric from collapsing into the spinning propeller when there is no relative wind to keep it deployed.



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PILOTS of No. 41 Squadron, on 10 min. alert, head for their Javelins at dawn. Note Firestreak missiles mounted under wings.

British Test Air Defense Against Simulated N

By Herbert J. Coleman

London—Britain's air defense forces withstood a week-long series of attacks from invading aircraft carrying simulated nuclear weapons in an exercise involving Victor bombers (Operation Mayflight), Bloodhound air defense missile sites and the Royal Air Force's Fighter Command (Operation Matador).

In the seven-day period, during which pilots were rarely stood down for more than a few hours, Fighter Command flew hundreds of sorties from permanent stations and dispersal sites, intercepting a combined force of bombers and fighters from NATO bases in Germany and France.

The exercise also included the Royal Observer Corps, primarily in the field of nuclear fallout reporting and damage control.

In a determined effort aimed toward realism, each military station assumed readiness for nuclear attack and reacted to bomb damage and fallout as expected during an actual attack.

Primary responsibility for air defense fell to Fighter Command, and the RAF used English Electric P.1 Lightnings, Gloster Javelins and Hawker Hunters to repel attacks. Major airborne weapon was the de Havilland Firestreak air-to-air missile, plus 30-mm. Aden cannons mounted on the Lightnings and Javelins.

Their targets were Victor and Vulcan bombers of RAF's Bomber Command, and a mix of NATO aircraft that included RAF Canberras; North American F-100s, McDonnell F-101s and Convair F-102s, of 17th Air Force; Royal Canadian Air Force Avro CF-100s, and French Sud 4050 Vautour twin-jet tactical support planes. These planes were not used as fighters; instead, they simulated tactics normally used by light bombers.

In the initial phase of the combined exercise, the V-bombers reacted to a threat of attack by dispersing to various satellite airfields. RAF has never revealed the number of V-bombers now operational, but there are somewhat more than 100 now in line duty. Dispersed, they probably were based at up to 40 different airfields, some of which had runways no longer than 6,000 ft.

After the first phase, the V-bombers turned into aggressor forces and, joined by the NATO airplanes, made the first attempt to penetrate the United Kingdom defenses, entering in waves from the North Sea at extremely high altitudes, in excess of 43,000 ft.

To watch Fighter Command in action, this AVIATION WEEK editor went to Wattisham RAF Station, near Stowmarket, Suffolk, one of the famed Battle of Britain fighter bases which was heavily bombed during 1940. A few unused pillboxes and a Spitfire on static display at Headquarters Building are the only reminders—Wattisham long since has become a jet fighter base and, in the event of actual war, would be in the front line since it is fairly close to the English Channel.

Wattisham also is the home of No. 111 Squadron, the widely acclaimed

ENGLISH ELECTRIC Lightning pilots man their aircraft on 3 min. alert at Wattisham RAF station. Only one of these Lightnings was kept on ground during scramble. Bullet in nose intake of each plane contains Ferranti Airpass radar.

JAVELIN pilots are shown firing up their engines for an early morning scramble. No. 41 Squadron had no aborts on this mission.

Nuclear Attack

Treble One squadron of aerobatic formation note. Treble One now is phasing from the Hunter into Lightnings and did not participate in the exercise on an alert basis. Most Treble One pilots continued their normal Lightning simulator and ground school duties, except when nuclear fallout forced them into station emergency routines.

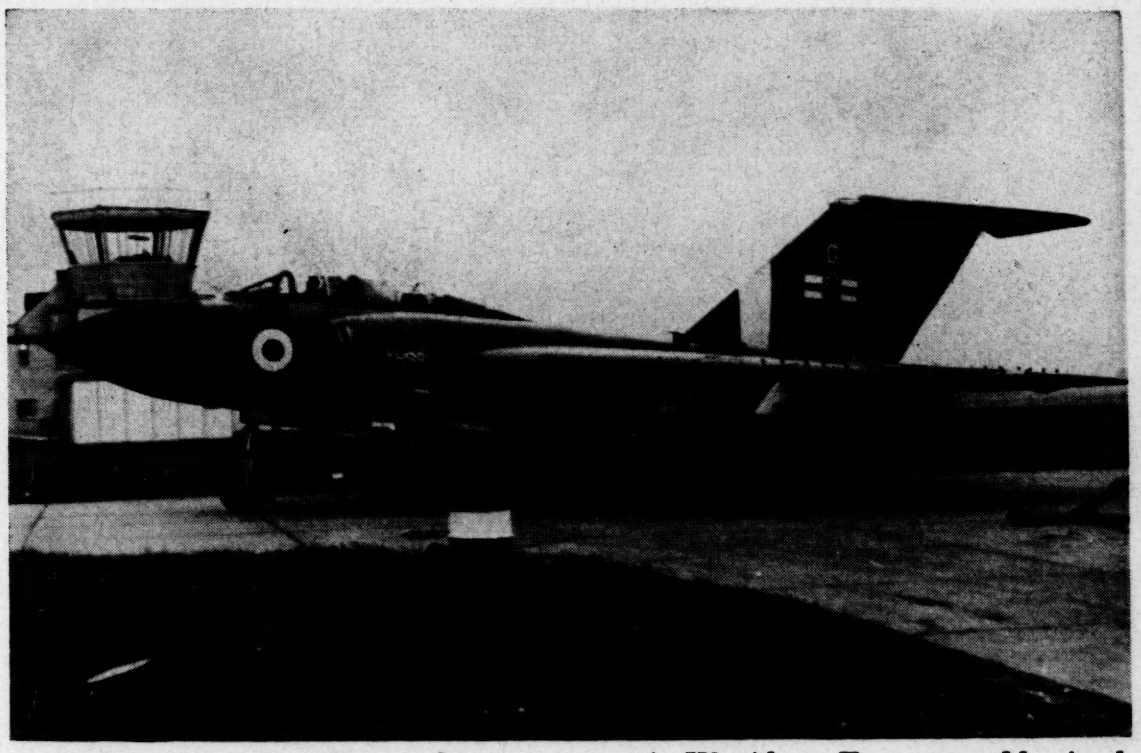
Because of the relatively high speed with which the Lightnings and Javelins now can be launched, the airplanes no longer are in dispersal areas; both squadrons, No. 56 (Lightnings) and No. 41 (Javelins), remained in readiness in facing lines on the main ramp.

On this visit, the squadrons went on 3 hr. alert at 3:35 a.m.; by 6:30 a.m. the pilots were on 3 min. alert and were in the cockpits with ground crews standing by for startup. Scramble came at 7 a.m. and the first Lightning was airborne in 2 min. 50 sec. from the roll.

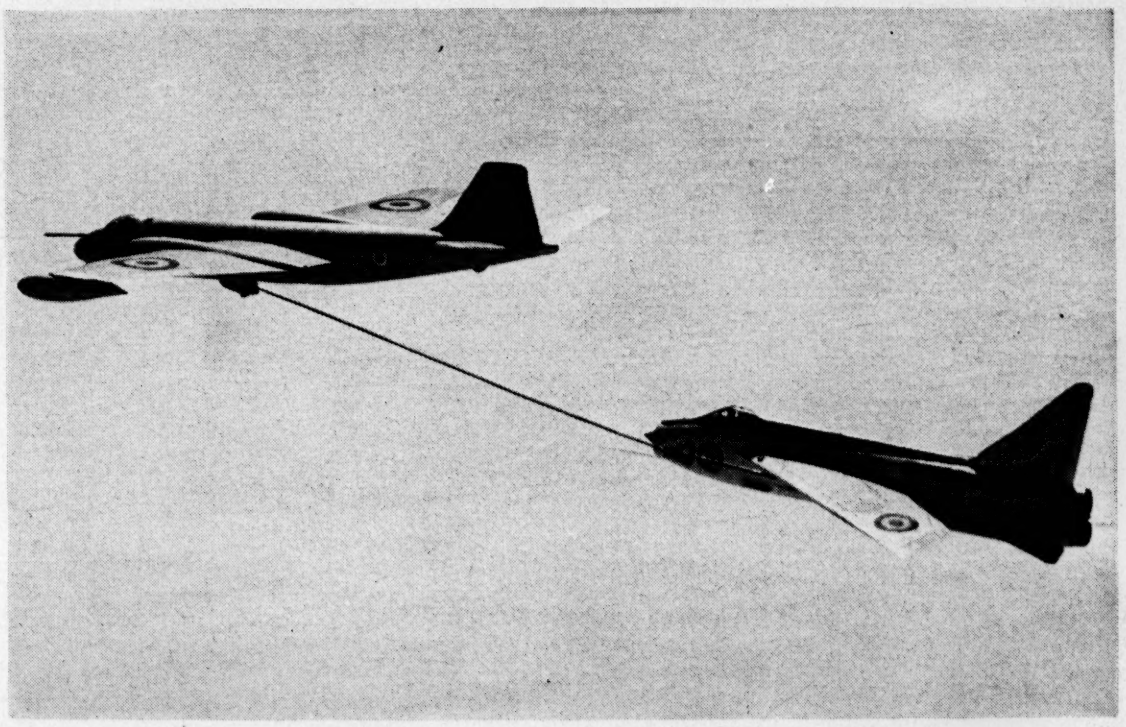
In all, this alert involved nine Lightnings and 15 Javelins; none aborted and there were no major maintenance squawks. One Lightning remained behind but only because it was due for engine change and had not been scheduled for that day's alert.

The airplanes were scrambled in a mix, in that Javelins took off behind Lightnings, or vice versa, depending on which airplane reached the takeoff point first. To the ground observer, the takeoffs were startling; often, airplanes were only a few hundred yards apart with gear coming up, and the faster Lightnings occasionally passed the Javelins in the pattern.

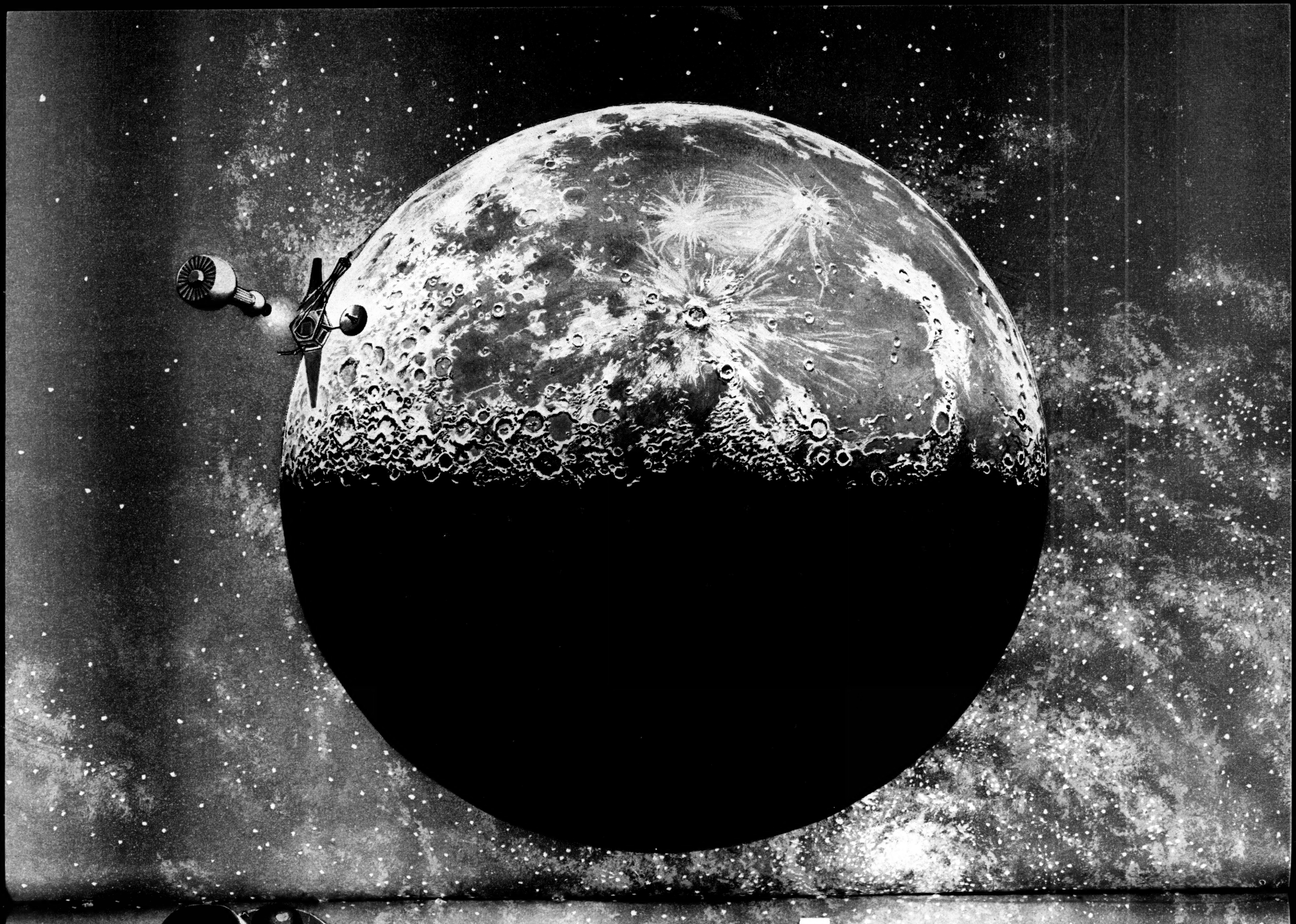
Lightnings are equipped with afterburners on their Rolls-Royce Avon jet



JAVELIN pilot and navigator/radar operator await Wattisham Tower scramble signal.



FIRST PHOTO of an English Electric P.1 Lightning jet fighter refueling from an English Electric Canberra twin-jet bomber modified for aerial tanker role. Lightning is fitted with probe under left wing; drogue retracts into housing on belly of the Canberra.



LUNAR PROBE

The moon — lacking an erosive atmosphere — may hold the key to the history of the solar system. Because of this lack of atmosphere, oceans, and wind, lunar explorations may help solve fundamental, universal questions.

Logically, the moon will be the first objective in the exploration of space. Initially the moon itself will be photographed and instrumented; then manned observation stations will be established for astronomical and meteorological purposes. In time, the moon will serve as an intermediate station enroute to other planets — step by step into infinite space.

The National Aeronautics and Space Administration's Lunar Program will utilize Lockheed's AGENA B satellite to play a significant part in forthcoming lunar explorations — as well as a host of other scientific space missions. The NASA lunar launch in 1961-62 will utilize the highly reliable Lockheed AGENA as second stage to carry the RANGER spacecraft. The AGENA will provide the extremely critical guidance and controls necessary to place the RANGER on the required lunar impact trajectory.

The lunar probe application demonstrates the versatility, reliability and success of the AGENA vehicle in Lockheed's satellite and spacecraft programs. Developed for the Air Force for use in the DISCOVERER program, the AGENA also is utilized in the MIDAS missile defense alarm system. Noted for a record of outstanding accomplishments, the AGENA is credited with being the first to be placed on a polar orbit; first to achieve a precise, predicted and nearly circular orbit; first to attain attitude control on orbit; first to eject a reentry capsule which was successfully recovered. The AGENA can be modified for a variety of missions such as navigation, geophysical investigations, long-range communications and deep space probes.

Lockheed's capability in satellites and spacecraft, manifested by such an achievement as the AGENA, encompasses the entire field. It includes current and long-range programs such as interplanetary probes, global and space communication systems, and manned space travel.

Engineers and Scientists: The accomplishment of such programs offers challenging opportunities to engineers and scientists in the research, design, development, test and operation phases of these programs. If you are experienced in work related to any of the above areas, you are invited to write: Research and Development Staff, Dept. M-29B, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.
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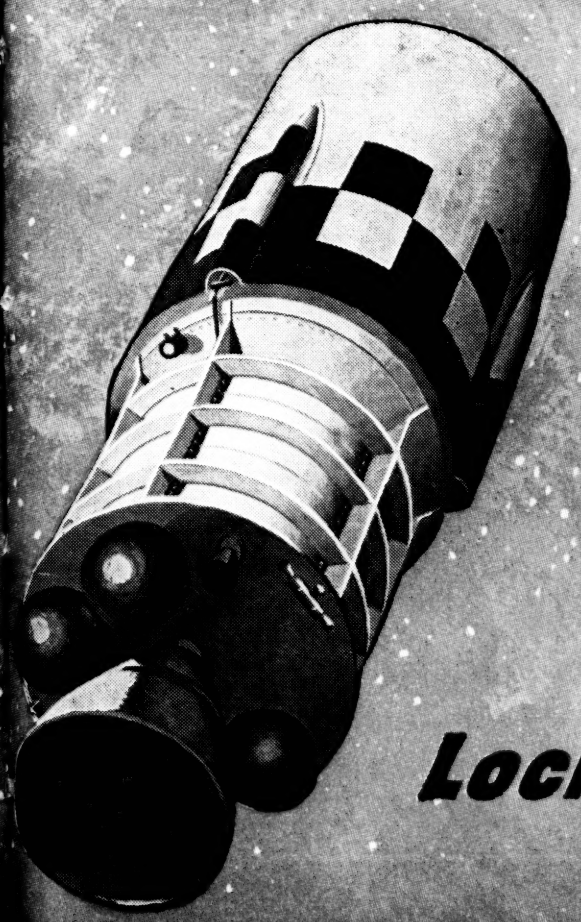

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Ultra-sonic checkout: sound waves are bounced through honeycomb panels under water to inspect brazing.

Mach 3 Manufacturing

Sounding out the inner secrets of brazed honeycomb panels

Manned aircraft are built with brazed panels of stainless-steel honeycomb in order to fly for hours at supersonic speeds. But inspection of these panels becomes a major problem because the interior of brazed honeycomb panels cannot be seen.

To solve this problem in designing the Air Force's new B-70 Valkyrie airplane, a special Quality Control Development Program was undertaken at the Los Angeles Division of North American Aviation.

The result: ultra-sonic inspection, a process that works like the Navy's sonar systems for locating submarines. By immersing each finished panel into a tank of water and then traversing a scanning head over it, sound waves are transmitted into the panel and reflected back to the scanning head. The reflections are recorded on photo-sensitized paper for a permanent record of every minute area where honeycomb and skin are brazed together. Any area that has been improperly brazed will show up instantly.

This method of inspection is just one of the many processes and advances in Mach 3 manufacturing that have been evolved by North American development programs. Other advances cover the full spectrum of triple-sonic fabrication. As a result of these programs, North American Aviation has met the challenge of Mach 3 manufacturing.

Builders of the B-70 Valkyrie

THE LOS ANGELES DIVISION OF **NORTH AMERICAN AVIATION, INC.**

engines, placed one atop the other, but these were not used during the alert. The airplane has an extremely high rate of climb and most reached operational altitude while still in sight of Wattisham. Later, in a demonstration, a Lightning, using the burners, was off the ground in less than half the 9,000-ft. runway, and its contrail showed up less than two minutes later, when the airplane probably was passing through 25,000 ft.

Not long after the scramble, a "nuclear bomb" was dropped near The Wash, north of Wattisham, and the field personnel went into a reaction exercise that involved every man—cooks, bakers, mechanics and clerks. All are assigned to damage control and took their stations until simulated fallout drove them under cover, in this case, any brick structure.

Nuclear defense training is a way of life at Wattisham, according to Group Capt. B. P. T. Horsley, the station commander. Drills are called constantly, with no warning, and all participate with exception of station security personnel who, incidentally, do most of their patroling with specially trained police dogs.

This particular scramble involved an attack on Victor bombers entering the United Kingdom from the northwest. The Lightnings and Javelins were vectored to attack position from widely dispersed control sectors, directed from Fighter Command Headquarters at Bentley Priory, Stanmore, near London. Officer in charge was Air Marshal Sir Hector McGregor, Fighter Command chief. The V-bombers were directed by Air Marshal Sir Kenneth Cross, head of Bomber Command.

Although the two squadrons based at Wattisham reported 100% success in their attacks, using both Firestreaks and cannon, some of the V-bombers penetrated the U. K., simulating nuclear bomb drops. In an unspecified number of cases, these bombs "knocked out" fighter bases and these sites theoretically were lost. Often, when a base was "bombed," the aircraft had been scrambled and were airborne; in this event, they were sent to operational sites by Fighter Command control. One fighter pilot landed on three different bases, two in Yorkshire and another in Scotland, in a single daytime period, because his bases were eliminated.

The hazard of nuclear fallout was constantly emphasized and it affected the missions in other ways than airport damage. For instance, a number of radar sites were subjected to heavy fallout and the personnel considered dead; this was cause for a quick shift by defense controllers to other methods of detection, including mobile units.

In the Wattisham area, "nuclear fallout" was pronounced and, at one pe-

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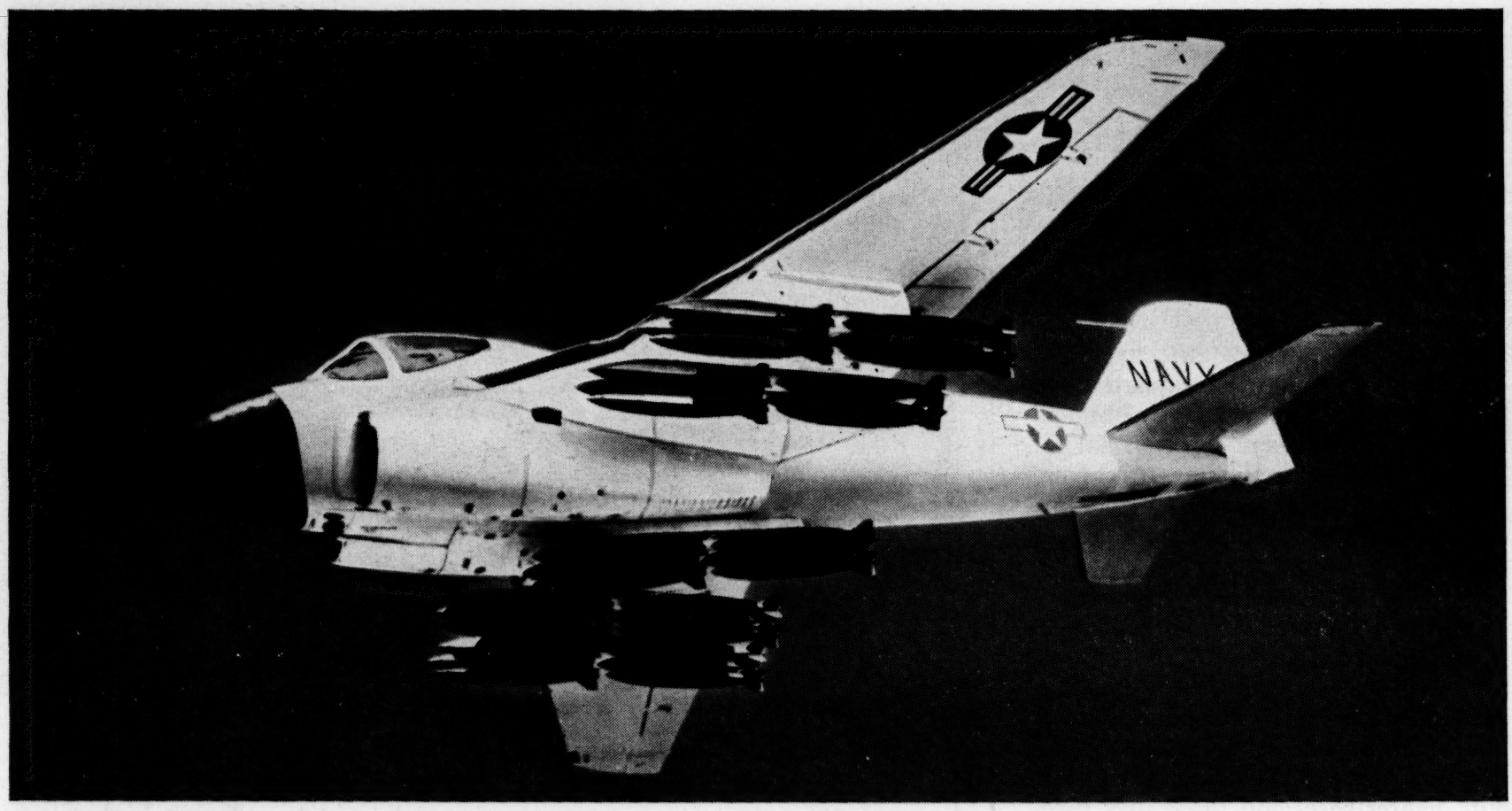
The A2F-1 Intruder

◀ *Illustration shows artist's conception of Grumman F9F Panther operating in Korea.*

▼ *A2F-1 Intruder with total of thirty 500-pound bombs in clusters of three from wing stations.*



This is the Grumman A2F-1 Intruder attack aircraft—an airborne weapons system developed for the basic purpose of fighting a limited or brushfire war. It was based upon limited war combat experience gained in Korea.

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Operated as an air-to-ground, missile-carrying aircraft, or equipped to carry conventional weapons of all types as well as nuclear weapons, the A2F-1 Intruder provides the U.S. Navy with an all-weather attack aircraft with extended range and heavy weapon capacity. In nuclear attack, the aircraft can come in low under enemy radar . . . too low for effective interference by enemy aircraft and ground fire.

The Intruder provides a new capability in close support missions—provides the nation with a powerful deterrent to prevent war and preserve peace.

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riod of the mock raid, was up in the 200 roentgen area. During this time, the base took on a deserted aspect, with all men under cover. Later, while this editor was following a Lightning scramble in a Hunter T.7 (two-place trainer), the flight was scrubbed by Wattisham control and we returned to the ramp; a "nuclear bomb" had knocked out the area control and emergency units could handle only airborne aircraft.

At no time were Wattisham's senior officers—Group Capt. Horsley, Wing Commander (Flying) A. D. Woodcock or Wing Commander (Technical) L. J. Jenkins—warned of attacks. Several times pilots went on cockpit alert, only to have the mission canceled. At another station, however, one pilot flew five sorties in a 24-hr. period. On the final day, Fighter Command took to the air against more than 200 airplanes attempting penetration from the continent. This attack involved use of electronic countermeasures by attackers to complicate the interception job.

Fighter Command spokesmen noted that since the United Kingdom now is part of the West Europe Air Defense effort, continental radar was available for early warning. The command also maintained a direct link with North American Air Defense Command (Norad) headquarters in Colorado Springs, Colo., to report developments.

The exercise was planned with the amount of warning time retaliatory and defense aircraft could expect from airplanes and missiles launched from the Soviet Union. The times were 15 min. for supersonic bombers and 40 min. for subsonic bombers, down to 4 min. for a 650-mi. range ballistic missile. This set the pattern for the pilot alert status—30 min. (blue); 10 min. (red); 5 min. (black) and 3 min. (amber). Amber alert is the cockpit alert; on red and black, pilots are on the line but not necessarily in the aircraft.

As part of the nuclear deterrent, Britain's Thor bases, strung in a line down eastern England from Yorkshire to Norfolk, were also on an alert status. On the civil defense phase, about 15,000 members of the Royal Observer Corps, all volunteers, took part in nuclear incident and fallout exercises.

PRODUCTION BRIEFING

Collins Radio Co., Cedar Rapids, Iowa has received contracts totaling $3.3 million in recent weeks for its airborne distance measuring equipment. Purchasers of the equipment include seven airlines, corporate aircraft owners and Lockheed Aircraft Corp. The Federal Aviation Agency is operating 344 Vortac stations and plans 833 installations by 1966. The military is operating 225 DME-compatible Tacan stations.

Northrop Corp.'s Norair Division will investigate behavior and heat transfer characteristics of liquids in a weightless environment under a six-month research contract from National Aeronautics and Space Administration's Lewis Research Center, Cleveland.

Autonetics Division of North American Aviation, Inc., Downey, Calif. will produce ship's inertial navigation systems (SINS) under $21-million Navy contract. The navigation systems are for nine Lafayette-class fleet ballistic missile submarines. The contracts call for three SINS for each submarine plus spares.

Beech Aircraft Corp., Boulder, Colo. will build 75 topping control units for the Atlas ICBM under contract from Convair (Astronautics) Division of General Dynamics. The topping control unit is built into the missile silo to provide liquid oxygen to the Atlas immediately prior to launch.

North American Aviation's B-70 bomber crew compartment will be tested under simulated flight loads in a hydrostatic tank being installed in the company's Aerospace Laboratory. Loads as high as 20,000 lb. will be applied to the fuselage structure through a dummy nose section. Hydraulic jacks will exert

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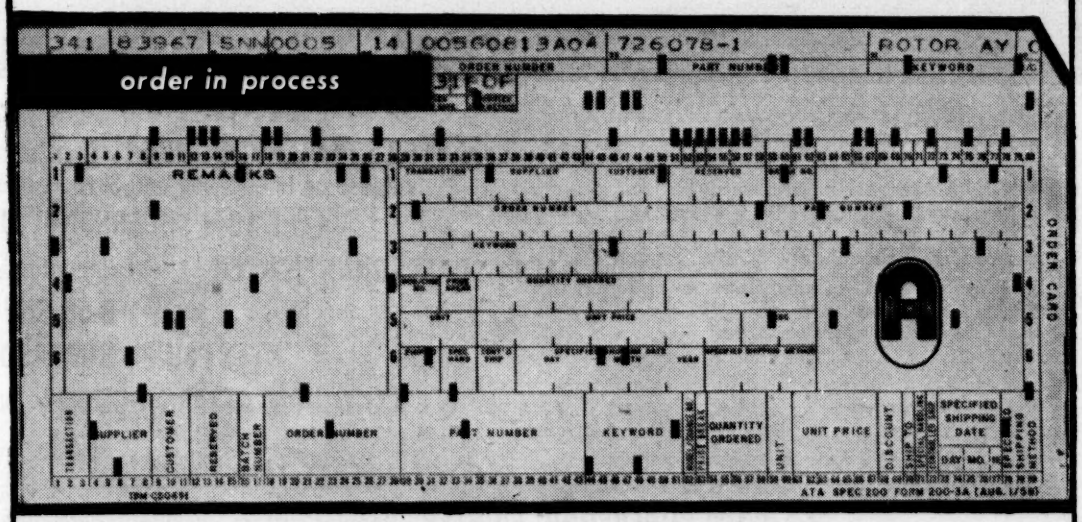

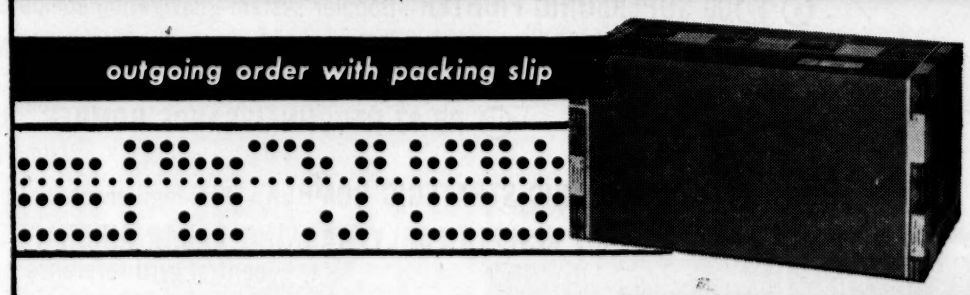

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⑨ **RF-101 SUPERSONIC RECONNAISSANCE FIGHTER**—Doppler system and roll-stabilized directional gyro compass system by General Precision

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⑬ **A3D-2 NAVY ATTACK BOMBER**—Bombing-Navigation computer by General Precision

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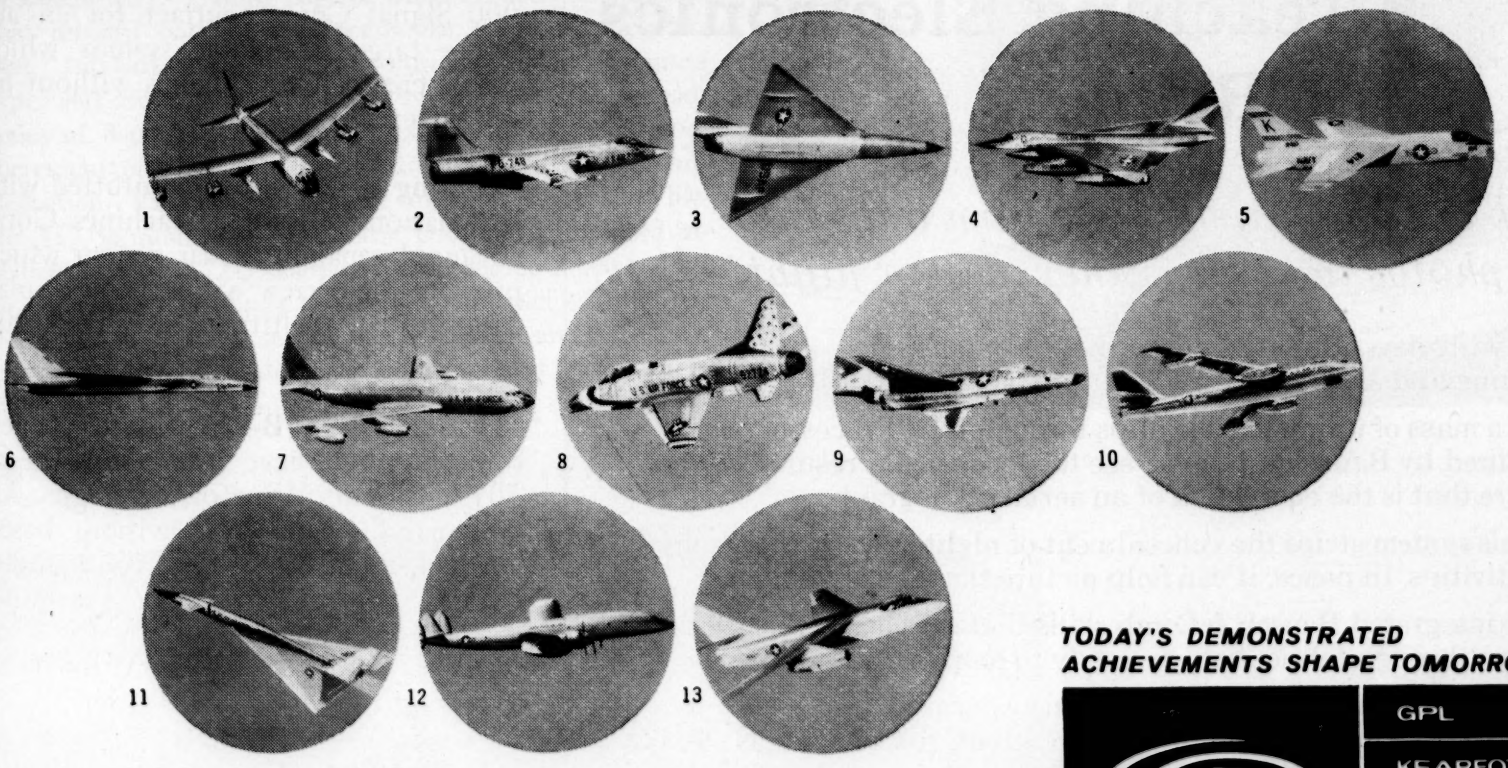
Manned aircraft of the aerospace age share a common reliance on General Precision's electronic and electromechanical systems in the performance of complex missions. Nearly all advanced aircraft flown by our armed forces incorporate General Precision navigation and heading reference equipment. In addition, the fliers that man the aircraft have been largely trained on General Precision flight simulators.

The four divisions of General Precision, Inc., are consolidated for the systems management of major new weapons and space projects. As a result, a manned-aircraft systems program can draw upon more than 16,000 General Precision employees (including 4,500 scientists, engineers and technicians) and well over 2½ million square feet of combined plant space.

This combination of talents and facilities, backed by the corporate financial resources of General Precision, Inc., makes it possible to develop, produce and manage any advanced system for manned aircraft.



GENERAL PRECISION, INC.

PRINCIPAL OPERATING SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

Tarrytown, N.Y.

TODAY'S DEMONSTRATED ACHIEVEMENTS SHAPE TOMORROW

GPL
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Teaching Electronics to Read

Bausch & Lomb capabilities turn blips into aerial photos in any weather, day or night.

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In war, this system strips the concealment of night and weather from enemy activities. In peace, it can help picture the face of the moon.

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additional forces to simulate rough weather and maneuver conditions.

Kollsman Instrument Corp., Elmhurst, N. Y., will produce automatic astro compasses for the Boeing B-52 under $9.5-million USAF contract. Similar star trackers are produced by the company for the Convair B-58, the North American Hound Dog air-to-surface missile and submarines.

Tracerlab has received contracts amounting to $80,000 from the Goddard Space Flight Center to research and develop means of detecting atomic gases in outer space. Research will necessitate design and construction of laboratory systems for production of free radicals, particularly atomic oxygen, hydrogen and nitrogen.

Electro-Optical Systems, Inc., Pasadena, has run a three milli-pound thrust cesium-ion engine continuously for 175 hr., with no failure, under a research and development program for USAF's Aeronautical Systems Division.

Aerospace Controls Co. has been formed to develop and manufacture special instruments and controls for space travel and related applications. The new firm is located at 602 Colorado Avenue, Santa Monica, Calif.

General Electric Co. has been awarded a $24-million contract extension from Navy for production of the AN/SPS-30 long-range, height-finding radar—making a total of $36 million committed to the project.

Hallicrafters Co. was awarded a $350,000 Signal Corps contract for an airborne target simulator system which would create ICBM signals without firing target missiles.

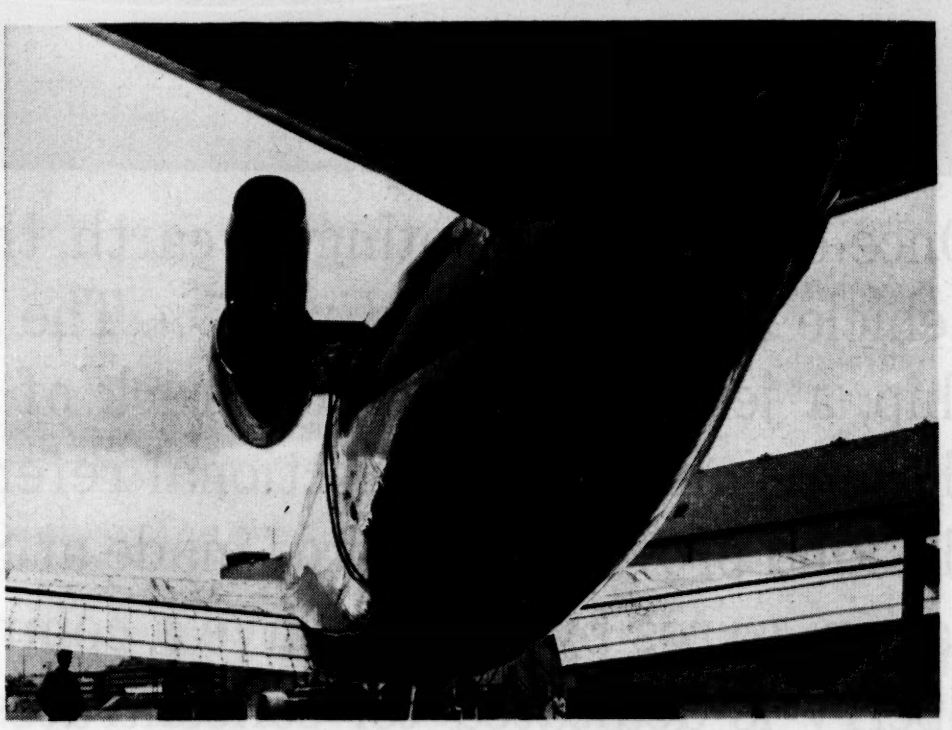
Boeing B-52H is being outfitted with International Business Machines Corp. advanced capability radar system which provides flight crew with terrain display for operation at altitudes less than 1,000 ft.

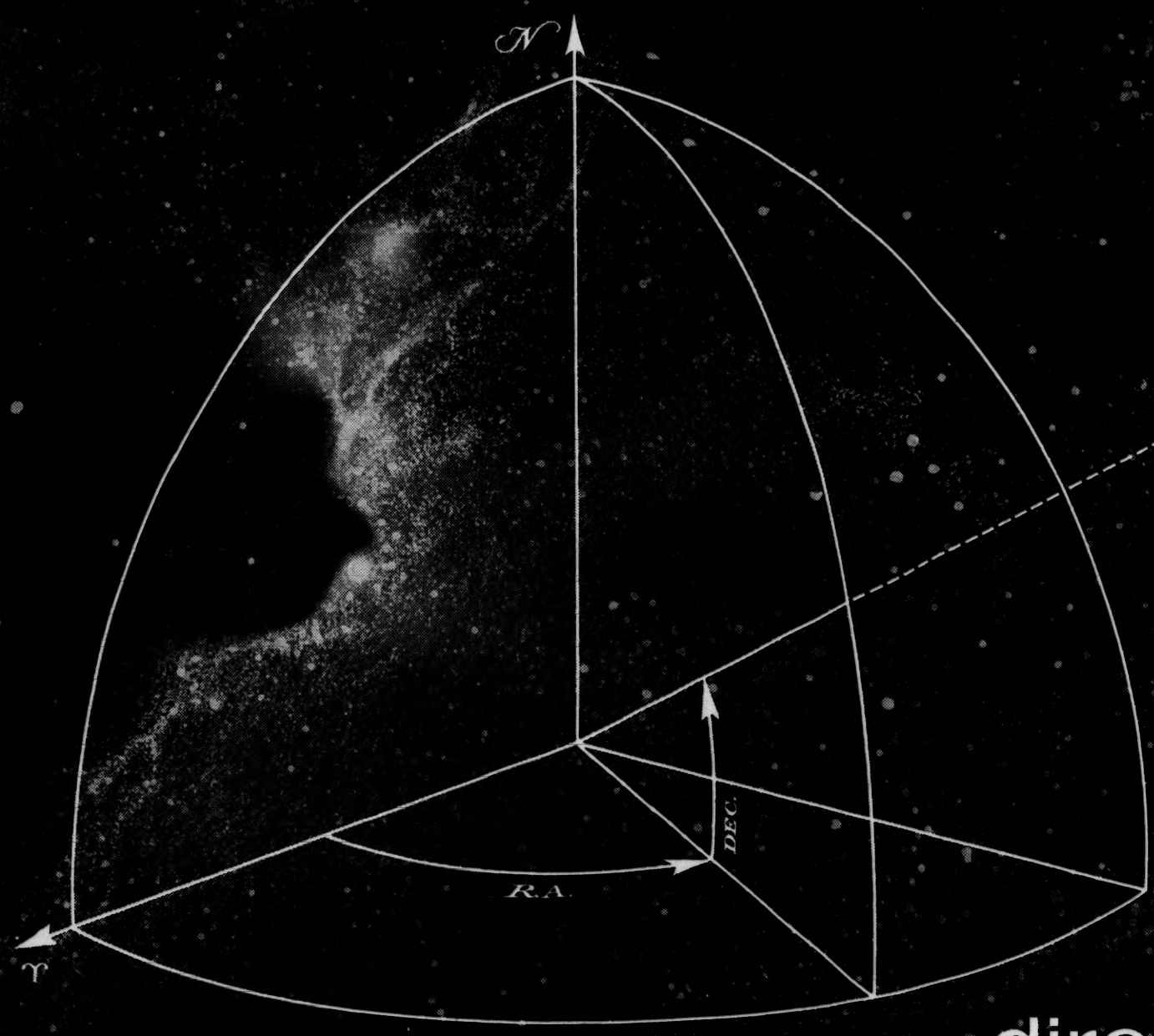
First Convair B-58A Hustler supersonic bombers have been delivered to 305th Bomb Wing of Strategic Air Command's 19th Air Division, based at Bunker Hill AFB, Ind., commanded by Col. Frank L. O'Brien. Personnel of the 305th were trained by the 43rd Bomber Wing, Carswell AFB, Tex., first wing to receive the Hustler.

Collins Radio Co. has been awarded two contracts totaling $1.5 million for communication, navigation and identification (CNI) airborne systems and another for $640,679 for CNI ground support systems.

Boeing 727 Wing Geometry, Nacelle Flight-Tested on 707 Prototype

Entire leading edge of the 707 prototype has been modified to install Krueger nose flaps between fuselage and inboard powerplant, and slats from the inboard nacelle to wingtip for flight-testing of wing geometry and outboard nacelle of Boeing 727. Trailing edge of wing has been modified so that inboard portion is perpendicular to fuselage centerline. Inboard flaps are double-slotted, double-segmented type, and are not retractable for prototype tests. Instead, series of flaps has been built, each set having a different increment of deflection from zero to almost 90 deg. full deflection. Engine nacelle, built around a Pratt & Whitney J57, is mounted in geometric position of outboard installations on the 727. Tailpipe of test engine is cranked up to get exhaust discharge above horizontal tail of the 707. Nacelle and inboard section of port wing are tufted for evaluation of flow conditions at high angles of attack where inlet and wing are approaching stall.



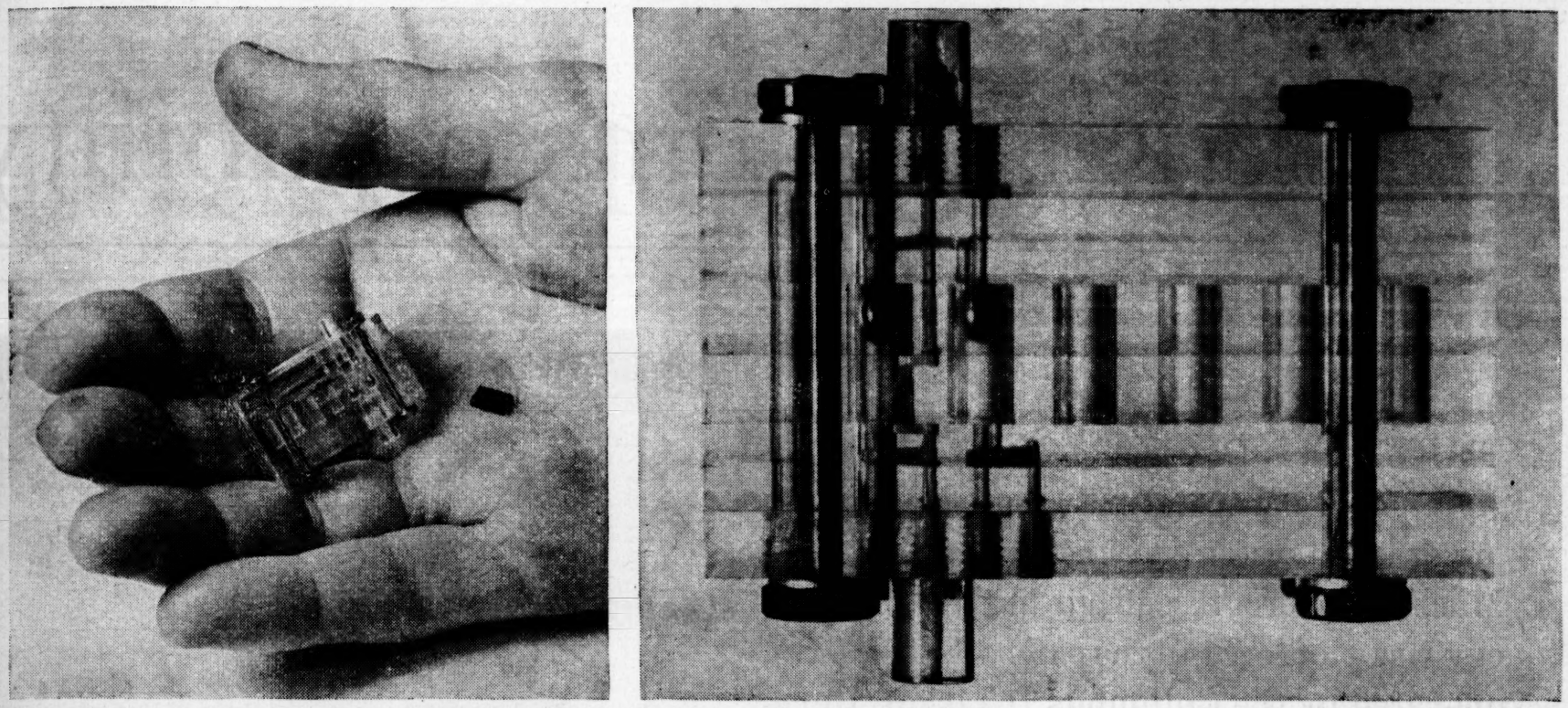


direction

Once off the firm footing of earth, the most critical need of any vehicle is for precise *direction*. The straight course of a sub, a ship, a jet... the precision track of missile or space vehicle... these result from a directional reference of superior accuracy; the kind provided by gyros made at Sperry. Whatever the application, gyros by Sperry have a common denominator: stability. Sperry is dedicated to, concentrates upon, stability – absolute directional accuracy, absolute repeatability. The result is seen in the widespread technological successes achieved at the direction of the Sperry gyroscope. General offices: Great Neck, N.Y.

Sperry gyros are the precise directional reference in these and many other applications: pinpoint navigation for the Polaris subs; automatic steering for advanced vessels such as the N.S. Savannah; automatic flight controls for the DC-8 and other aircraft; precision bomb-nav system for the B-58 "Hustler"; miniaturized gyros for space vehicles (symbolized in main illustration).

SPERRY



PNEUMATIC digital computer, under development by Kearfott, will employ tiny gas-operated flip-flops. Tiny black package contains six pneumatic flip-flop circuits. Larger, transparent laboratory model is shown alongside at left. Close-up (right) of transparent model shows two bistable elements at left and provisions for adding four more elements at right. Company says it can build 3,000 such elements in one cubic inch volume and produce pneumatic digital computer that measures only 5½ x 5½ x 1 in.

Pneumatic Computer Suitable for Space

Digital computer that uses air/gas operated flip-flops and diodes instead of electronic elements, enabling it to operate at temperatures up to 2,000F in a severe radiation environment, is being developed by Kearfott, a division of General Precision, Inc.

These characteristics, coupled with the small size, weight and low cost, suggest that the pneumatic digital computer may find use in space vehicles for guidance and control.

Progress Sited

Progress to date prompts Kearfott to predict that pneumatic digital computers will be able to operate at clock frequencies of 10 kc. to 100 kc., a moderate speed which should be adequate for many applications.

Company says that approximately 3,000 pneumatic flip-flops and their interconnecting "circuitry" and power supply can be built into a one cubic inch package. A medium-size general purpose pneumatic computer, complete with memory, is expected to measure only 5½ x 5½ x 1 in., according to Kearfott.

Kearfott is not alone in the pneumatic digital computer field. The Soviet Union is known to be active in pneumatics for computing, as is the International Business Machines Corp. Laboratory in Zurich, Switzerland. Army's Diamond Ordnance Fuze Laboratory (DOFL) also is experimenting with pneumatic digital computer techniques.

In the Kearfott pneumatic digital computer, pneumatic analogs generally are substituted for more familiar electronic elements in order to permit the use of existing computer logic design, according to company's Hugh E. Riordan, senior staff engineer.

For example:

- **Pneumatic diode** is an orifice that operates above critical flow, i.e., with gas flowing through the throat at or above the speed of sound. Under such conditions, a pressure disturbance originating upstream of the orifice will move downstream through the throat, but a disturbance below the orifice cannot propagate back upstream. Because a pneumatic resistance is an orifice, or capillary, a pneumatic equivalent of a simple diode logic circuit requires only appropriate interconnection of orifices and capillaries of various sizes.
- **Pneumatic capacitance** is a plenum chamber.
- **Pneumatic inductance** is a "long" pipe of sufficiently large diameter so that viscous losses do not predominate.
- **Pneumatic bistable element** (flip-flop) employs a small ball-shaped shuttle in a cylindrical housing having four tubular connections. The ball is able to move freely from one end of the cylinder to the other.

The pneumatic flip-flop element can be operated in a number of different ways, Kearfott says. One of the simplest arrangements is shown on p. 83. A common pneumatic supply at pressure is connected to the flip-flop's two axial connections (1) and (2) through separate flow restricting orifices. The radial connections (3) and (4) are open to the atmosphere.

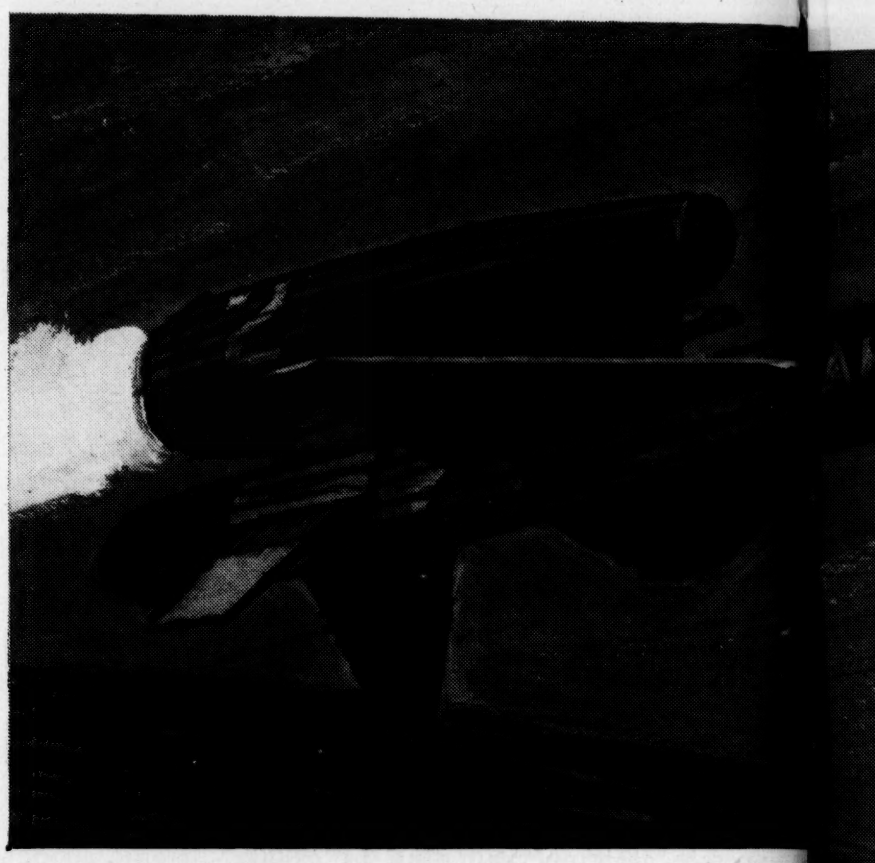
With the ball initially located at position "A," inlet (1) is closed by the ball so that the pressure at this point is equal to the supply pressure. There is flow through inlet (2) and out through (4), and since the ball does not provide a leak-tight fit in the cylinder, a small flow passes around the ball and out through (3).

Under this condition where are several forces acting on the ball which, with proper choice of design parameters, will keep the ball at (A) so long as side connections (3) and (4) remain open. But if radial connection (3) is closed, pressure on both sides of the ball will equalize because of leakage between the ball and the cylinder wall. In addition, there will remain a force acting on the seat-area of the ball trying to push it away from (A). As soon as the seal between the ball and the seat is broken, the supply pressure from (1) will act on the entire area of the ball and drive it rapidly toward position (B).

If the connection at (3) now is reopened, the ball will remain at position (B) under equilibrium conditions that previously prevailed when it was at position (A). If connection (4) now is momentarily closed, the previously

This is systems capability a

The Columbus Division of North American Aviation is one of the most complete centers of advanced systems technology in the world. Much of the progress in our modern technology was pioneered in the extensive facilities operated by the Columbus Division. Here practical production evolves swiftly from original concepts. Economy through efficiency is the constant theme. This is true systems management capability...this is the Columbus Division.



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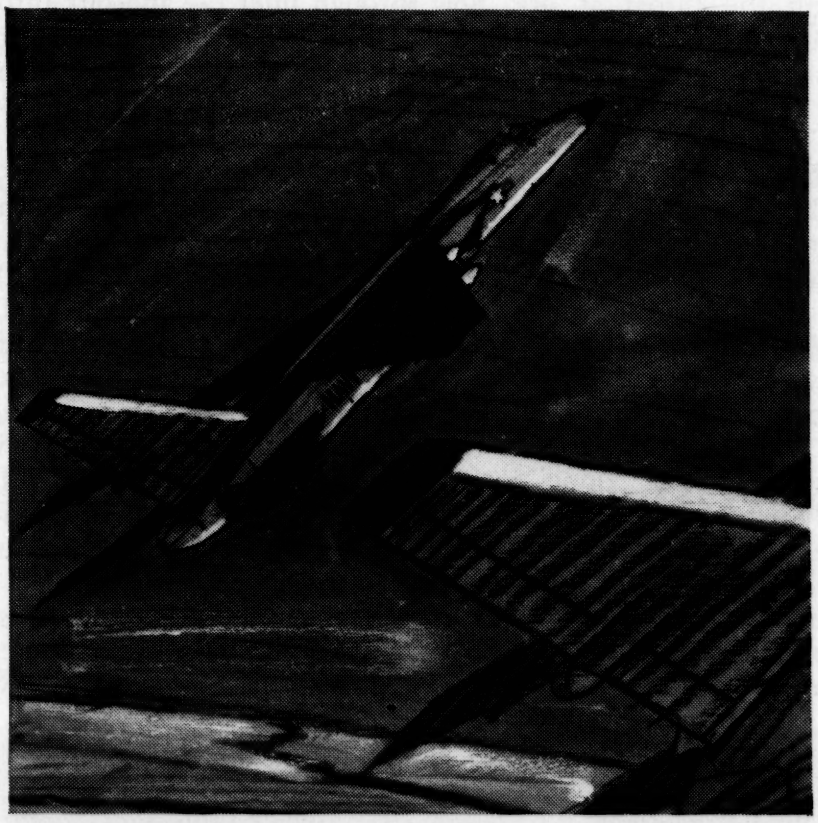
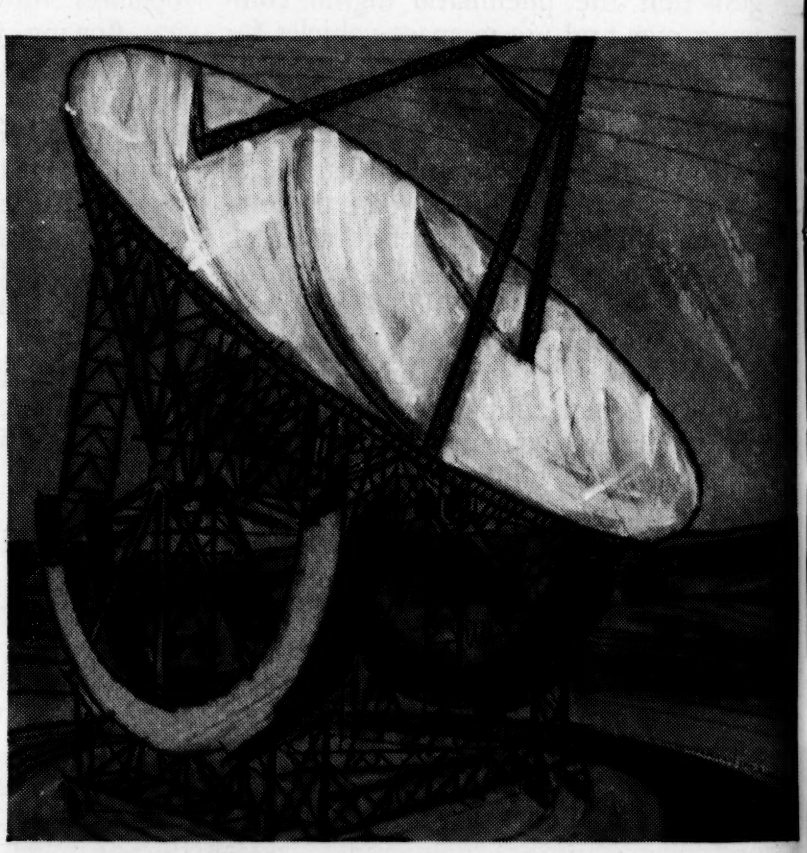


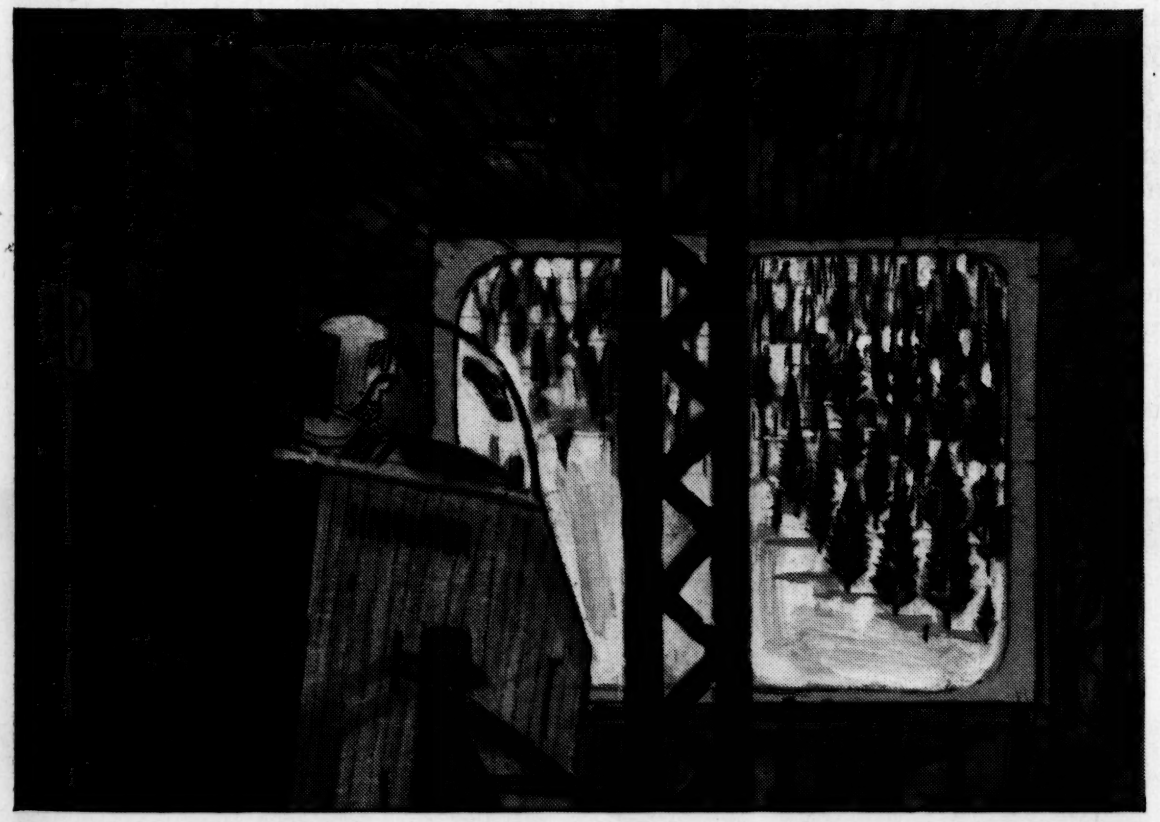
A3J VIGILANTE. Navy's A3J set a new world's record, flying to 91,450 ft. carrying a payload of 2,204 lbs. The versatile, carrier-based A3J can perform high or low level missions in any weather, from any attitude, day or night.



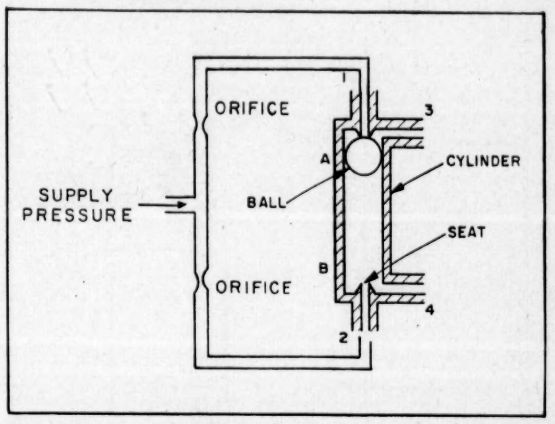
THE BIG "EAR." World's largest radio telescope reflector, six hundred feet in diameter, is being built by Columbus for the Navy in Sugar Grove, W. Virginia. Columbus is also building a complete antenna system for the USAF.

y at NAA-Columbus

TWO-IN-ONE TARGET MISSILE. New target missile NA-273 can carry out high- or low-level missions equally well. It performs from ground level to 60,000 feet, and from subsonic through Mach 2. Under development for the Army by the Columbus Division, it is launched by a rocket, and powered in flight by ramjet.



V/STOL FACILITIES. New six-degree-of-freedom flight simulator is part of facilities set up by Columbus Division to study requirements of vertical and short takeoff and landing aircraft design and development. Other V/STOL facilities include low-speed to transonic wind tunnel and unique lightweight ejection seat.



BASIC pneumatic bistable element uses ball in cylinder with two vents at each end. Under condition shown, closing vent (3) while (4) is open will cause ball to shift to bottom of cylinder and remain there when vent (3) is re-opened. Ball can be returned to original position by closing vent (4) while (3) remains open.

described process will be reversed and the ball will shift rapidly back to position (A) and remain there after connection (4) is reopened.

The pneumatic bistable element also can be operated by applying a pressure pulse to the radial connection which has the same effect in inhibiting outward flow as closure of the vent, providing a pulse-responsive pneumatic flip-flop. This mode of operation provides faster reaction time.

The output of the bistable element, for interconnection with similar units in the required computer logic, appears as a pressure drop across the supply orifices which are analogous to load resistors in a vacuum tube circuit. As with electrical circuits, the design requires "impedance matching" and consideration of loading requirements. To accomplish these functions, Kearfott has designed pneumatic buffering, oscillator and isolation circuits.

While most electronic circuit elements are best suited for bistable operation, pneumatic elements can be designed for tristable operation. One, which Kearfott has designed for use as a binary scaler, has a fifth connection at the center of the cylinder, in addition to the two at each end. When this center connection is open, the ball is driven to the center of the cylinder and remains there regardless of the condition at outlets (3) and (4). When the center outlet is closed, the device behaves as a conventional bistable element.

The use of moving balls in the Kearfott pneumatic computer elements does not make them susceptible to spurious operation under shock/vibration conditions, the company says. When a bistable element has a 100-psi. differential pressure across its terminals, a shock of more than 50,000g would be required to disturb the element, Kearfott says.

A number of convenient means can

Complete ground training, pre-flight and flight maneuvers with the

NEW "WHIRLYMITE" HELICOPTER SELF-TRAINER

Del Mar offers a dynamic new system to train helicopter pilots: the Whirlymite Self-Trainer. It is not a simulator, but an operational helicopter mounted on a highly mobile, air-cushion platform. The unique mounting of the platform permits full freedom to rotate in azimuth, rise vertically and tilt in all directions. Thus, the trainee practices all "in-flight" maneuvers without ever going more than inches off the ground... with the complete security of the no-tilt, air-cushion platform beneath him. Because it allows free movement across the ground, without friction, the air-cushion platform makes this system the first ground trainer capable of attaining transitional lift speeds in forward flight.

The Whirlymite Self-Trainer is designed to move the student through primary training right up to solo flight, without requiring dual flight instruction. That means a single instructor can handle a number of students, simultaneously, through the training program. And, when the primary training is completed, the Whirlymite may be easily detached from the platform to become an operational helicopter.

For complete information on this versatile, low-cost training system, write for Data File AW-1546-1.

Del Mar ENGINEERING LABORATORIES

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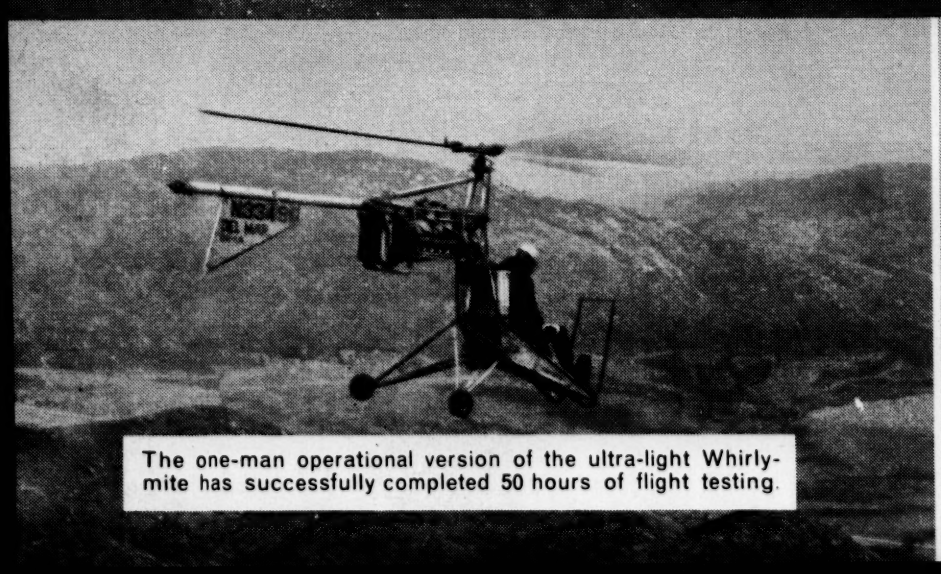
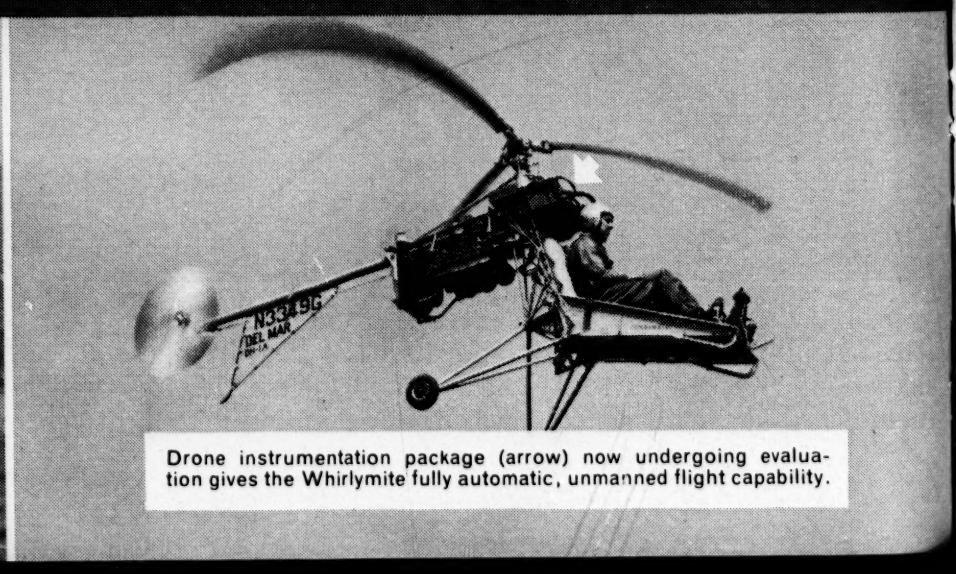


The one-man operational version of the ultra-light Whirlymite has successfully completed 50 hours of flight testing.



Drone instrumentation package (arrow) now undergoing evaluation gives the Whirlymite fully automatic, unmanned flight capability.

be used to convert electrical input signals to pneumatics for introduction into the computer, and for converting its output to electric signals for display or other utilization.

Electromagnetic coils or electrostatic plates can be used to force the ball of individual pneumatic elements into the required position in their chambers. To sense the position of the ball, for conversion of computer output, an external coil, capacitor plates or contacts embedded in the cylinder walls can be used, Kearfott says.

Because the bistable elements operate on the basis of pressure differentials rather than absolute pressures, a pneumatic computer does not require extremely precise control of supply pressure, temperature or leakage within the unit.

No absolute seals are required and it is only necessary that certain inequalities in leakage areas have the right sense and approximate magnitude.

Packaging Density

To achieve maximum packaging density, Kearfott proposes to construct pneumatic digital circuits from layers of perforated plates which can be made by mass production techniques and assembled to provide both the computer elements and the required interconnections between elements. This should permit standardization of parts and fabrication with only a few tailoring operations.

Present thinking calls for the use of five perforated plates and two solid outside plates. The outer pair of perforated plates, called matrix plates, will contain a herringbone pattern of grooves in their two faces. Circuit connections can be made by drilling through the matrix plates at the appropriate intersections of grooves.

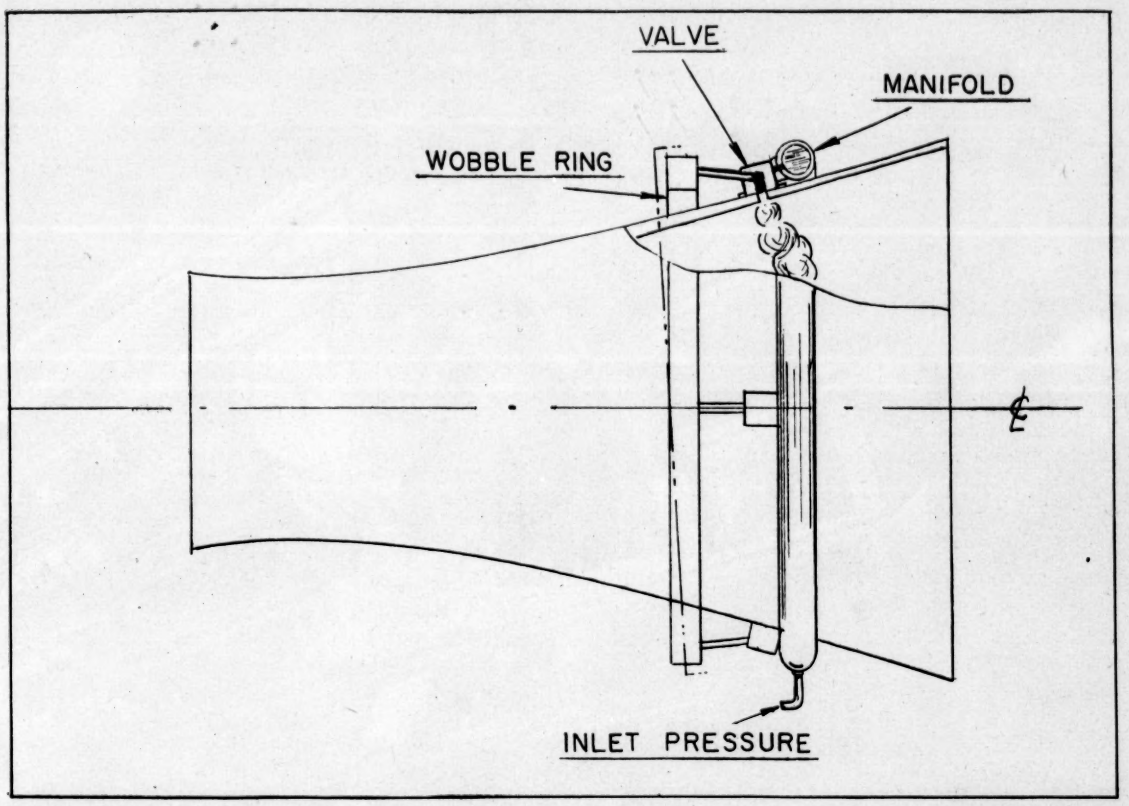
For moderate temperature operation, the matrix plates could be made of any material capable of being fabricated by chemical milling or photoetching.

For high temperature operation, ceramics or high temperature alloys would be used.

Typical tolerances and critical dimensions for pneumatic computer elements might be as follows:

- **Cylinder diameter:** 0.020 ±0.0005 in.
- **Moving element diameter:** 0.019 ±0.0002 in.
- **Port/orifice diameters:** 0.010 to 0.004 ±0.0002 in.

These tolerances are within the capabilities of existing machine tools and techniques, Kearfott points out. The small size of orifices and passages will, however, require the use of clean gas as a power source and/or filtering to three micron particle size, the company says.



INJECTION of bypass gas into the nozzle exhaust flow is being studied by Arde-Portland for thrust vector control of large solid boosters. Hot-gas valves, located 90 deg. apart on a manifold, feed bypass gas into stream, changing shock waves within nozzle. Wobble ring controls valves.

Gas Vectoring for Solids Studied

New York—Injection of bypass gas into the exhaust of a rocket engine nozzle is being studied by Arde-Portland, Inc., Paramus, N. J., for thrust vector control application on large solid propellant boosters.

Under this concept, called "continuous differential secondary injection" by the company, a thrust vector control system would work like this:

Hot gas is bled from the motor's combustion chamber and introduced into a circular manifold near the base of the nozzle.

Four valves, located 90 deg. apart on the manifold and partially open at all times, evenly leak the gas back into the main exhaust stream. As pitch, roll or yaw movements become necessary, the guidance system activates a wobble ring which, in turn, mechanically controls closing or further opening of valves.

Shock Wave Modified

As the wobble ring opens one or two valves on one side of the nozzle, it also closes the opposing valves by an equal degree, thus modifying the shock wave pattern and producing an unbalanced force within the nozzle.

Arde-Portland claims that a continuous, rather than a pulsed, or intermittent, injection system is preferable because the former maintains constant thrust and the use of preheated gas does not cause a temperature drop in the exhaust flow.

Also, in the continuous system, where the valves are always slightly open, large forces are not required to move the valves against chamber pressures of 500 psi. or higher.

The company said that the valves, which must function smoothly and rapidly at high temperatures and in a corrosive environment, are the critical link in a continuous injection system. Such a hot gas valve has been developed, Arde-Portland said, and will be tested soon.

Dyna-Soar Components

Subcontracts under the Air Force's Dyna-Soar space glider program have been awarded by Boeing Co. to:

- **Thompson Ramo Wooldridge's Tapco Group, Cleveland, Ohio, which will provide Dyna-Soar's reaction control power component under an R&D contract exceeding $1 million. The unit will stabilize and control the glider during flight through space or when the aerodynamic controls are not completely effective.**
- **Sundstrand Corp., Denver, Colo., which will develop an accessory power unit for the glider under a multi-million-dollar contract. The gaseous hydrogen-oxygen device will power the vehicle's generator in flight, will consist of a reaction chamber, prime mover, gear box, hydraulic pump, propellant shut-off valves, and metering valves and controls.**
- **Garrett Corp., Los Angeles, which will develop a hydrogen cooling system for Dyna-Soar. Hydrogen expelled from a storage tank will feed a heat exchanger to absorb the heat extracted from crew and equipment compartments.**

Mercury capsule's all-titanium frame of hat-section stringers and machined rings.

45,000 inches of welding

Titanium construction clinches record of reliability with Mercury capsule!

Mercury's astronaut, and all that was at stake with him, rode out the big shot safely in a titanium structure. Chosen for its light weight, its strength and rigidity at high temperatures, its ease of fabrication, titanium has passed another milestone in its growing history of reliability.

Project Mercury's pressurized capsule, its antenna and parachute housings and the adapter section mating it to the booster are basically titanium structures. They consist of a titanium inner skin attached to a framework of titanium stringers and rings. Beryllium and Rene 41 heat shielding "shingles" are fastened to the outside of the capsule.

The use of titanium has saved "considerable" weight over other metals of similar strength and endurance in the all-critical weight battle in the Mercury capsule and adapter section where ounces were fought for.

This report has been prepared by Titanium Metals Corporation of America in the belief that performance of titanium in the space capsule may provide information of use to you in design and construction of weight-critical airframe structures, whether they be in VTOL or STOL aircraft, or vehicles to operate in space.

Rigidity and strength at high temperatures . . . and 20 G's! Shaving off pounds was not enough for Mercury's designers. One of the big factors in the selection of titanium, which is as strong as most steels, yet weighs 44% less, is its ability to retain its strength and rigidity at high temperatures.

During the launch phase, the all-titanium adapter section reaches 600F. The titanium stringers in the capsule reach 600F during re-entry; the inner skin reaches 200F. Here titanium construction proves its high performance and reliability. Mercury capsule is designed to withstand 20 G's.

Titanium construction inherently rigid. Titanium lends itself to an actually stiffer construction even though its modulus is somewhat lower than steel's. The answer is a greater cross-section made possible by the less dense titanium. Moreover the metal will retain its stiffness over a wide range of temperatures.

Added stiffness and efficiency can be gained by "rigidizing" or beading. Mercury inner skin, which is also the cabin inner wall, consists of two layers of 0.010" commercially pure titanium, welded together to form a single "sandwich" structure. The inner layer is flat-rolled. The outer layer has been stiffened with corrugations approximately 3 inches in length and ½-inch wide. The result is a 0.020" titanium section that is equal in rigidity to an 0.050" section . . . 150% increase in efficiency.

45,000 inches of reliable welds per capsule. Project Mercury capsule, in addition to its high G loadings and temperature requirements, is pressurized to maintain its cargo of human life. Welds *must* be reliable.

According to McDonnell Aircraft, St. Louis, Mo., developers and manufacturers of the capsule, there are 24,500 inches of seam and butt weld and 20,500 inches of spot weld in each capsule . . . 45,000 inches of welding. The performance has been repeated in 20 production capsules.

Here indeed is a better focus on the reality of titanium welding!

All fusion and seam and spot welding was done "open air." Fusion welds were inert-gas shielded, tungsten-arc, using trailing and backup shields. Welds are as strong or stronger than parent metal, McDonnell reports.

Spot and seam welding was accomplished on standard production equipment, with techniques similar to those used on the stainless steels.

TMCA: your information source. If your missile or aircraft problems revolve around requirements for a rigid, high strength structure at temperatures from *minus* 433 to plus 1000F . . . with high corrosion resistance, including immunity to atmospheric attack, titanium may easily be your best answer. The reliability on which the makers of the Mercury capsule placed their faith can work for you.

We suggest you get in touch with the nearest Titanium Metals Corporation of America sales office or write directly to our Technical Service Department for information on titanium application . . . fabrication . . . competent fabricators. Why not write today . . .

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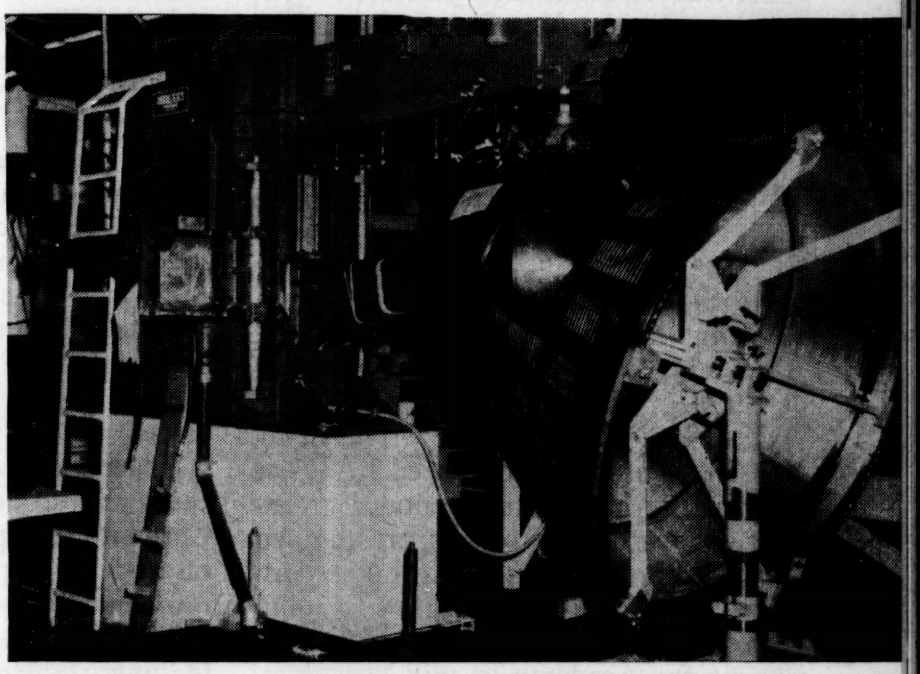
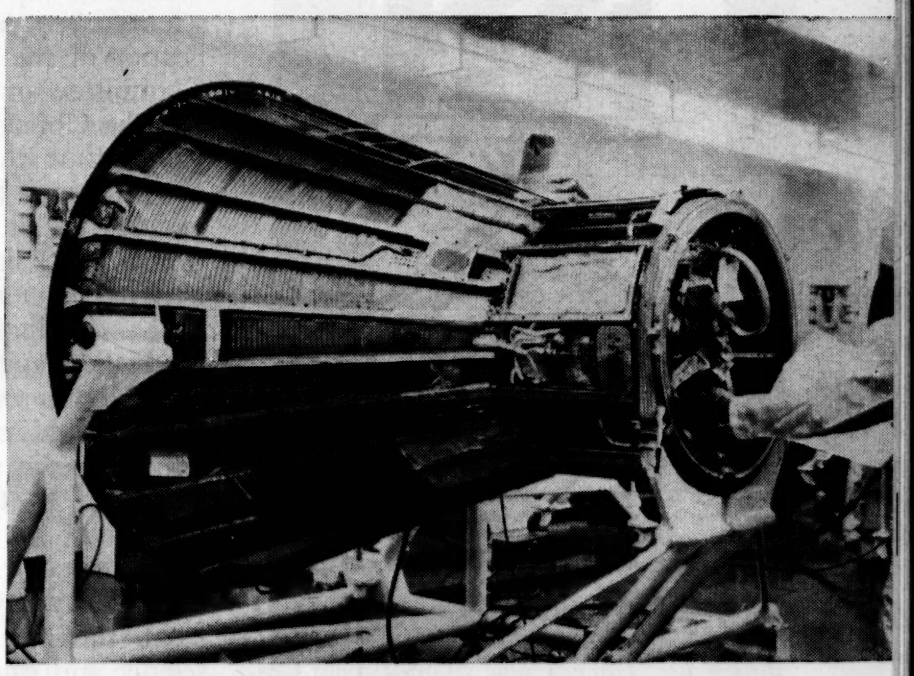
Titanium inner skin consists of two truncated cones 6½' high by 6½' at base, welded together. Cones are formed from trapezoidal sections, butt-welded together. One cone consists of 0.010" beaded titanium, for added stiffness; the other cone of flat-rolled 0.010" titanium. After butt-welding, each cone is individually pressure tested.



Cones are joined by seam-welding, the beaded cone on the outside, following spot-welding for position. Approximately 24,500" of seam weld are used in each capsule. A circumferential pass is made between each corrugation and a vertical pass adjacent to the corrugations. Joined cones are also proof-tested.



Basic titanium capsule structure consists of welded, two-layered cones which are spot welded to the titanium frame. The housing and adapter sections are not pressurized and consequently the skins are riveted to the frame in these areas.

Soviet Shuffle Keyed to Practical Science

Moscow—Russia is reorienting its entire scientific research program—including space and aeronautics—in an attempt to give greater emphasis to the application of practical technology.

Latest move in the general shakeup is the appointment of an aerodynamicist, Mstislav V. Keldysh, to head the Soviet Academy of Sciences. Described as a master organizer and the nation's leading space mathematician, Keldysh succeeds Aleksandr N. Nesmeyanov, 62, a chemist. Nesmeyanov stepped down at his own request, according to the Academy announcement.

The Soviet Academy of Sciences formerly had firm control over all USSR scientific research and education, but last month the Kremlin abolished the State Scientific and Technical Committee and gave broad powers to the new State Committee on Coordination of Scientific Research. The new committee can dictate research emphasis in any area, including those administered by the Academy.

Both moves apparently reflect a growing dissatisfaction with scientific efficiency, and the delay in translating technology into production goods (AW Feb. 13, p. 31). The Soviet Academy has frequently been criticized by Soviet officials for having an outmoded organization, whose workers are preoccupied with non-practical, theoretical problems.

Election of Keldysh, who was nominated by Nesmeyanov, came at a meeting of the Academy in mid-May. Nesmeyanov remains a member of the Academy's Presidium.

Keldysh has specialized in the study of motions of bodies in fluids. For several years he supervised research into dynamic strength and vibration of aircraft. He is credited with evolving the theory which led to control of sudden flutter in aircraft wings, and to the elimination of nose wheel vibration in aircraft landing gear.

The new Academy president also is credited with development of computer mathematics, automatic controls and hydrofoils.

His studies in aerodynamics contributed to Soviet missile airframe development.

The Soviet press is placing great stress on Keldysh's abilities as an organizer, and in accepting the presidency he voiced full support of Premier Nikita Khrushchev's reorganization of the Soviet Academy.

Nesmeyanov has admitted to the Soviet press that the huge network of Academy institutions has been "difficult to control," and the Academy has been directed to turn a number of its institutes over to state committees, ministries and departments.

The State Committee on Coordination of Scientific Research, operating directly under the Council of Ministers, is headed by Lt. Gen. M. V. Khrunichev. State Scientific and Technical Committee, responsible for coordinating research and speeding its introduction into industry, was abolished, according to Soviet reports, because it contributed to "unwarranted duplication of scientific research and the irrational use of scientific cadres and material resources."

Its chairman, Konstantin D. Petukhov, has been "transferred to other work."

Fullest explanation of the Soviet scientific reorganization came with publication of the decision, by the Central Committee of the Communist Party and the Council of Ministers, with the report that the most important task of all research institutions is to increase research in all areas, particularly those which have significant effects on the national economy.

". . . Bringing of science closer to production and ensuring of most rapid introduction of results of research in the national economy acquire special importance in present day conditions," according to the announcement. It stated that the large number of department research establishments in the USSR Academy "distracts the Academy from solving long-term problems in science and causes wasteful dispersal of funds."

Basic responsibility of Khrunichev's committee, according to the announcement, is "to guide the work research establishments are doing in key scientific and technical problems" in accordance with party and government directives. The committee will coordinate work of the USSR Academy of Sciences, the Union Republic Academies of Science, and all union ministries and departments engaged in scientific research.

The new committee will work with top Soviet planning agencies to draft long-range scientific goals and establish plans for the introduction of scientific and technical achievements in production.

Sweeping responsibility of the coordinating committee includes drafting plans for the national investment in scientific equipment, which presumably includes the level of effort for laboratory and applied research.

On Khrunichev's committee are the chairman for the State Committee on Automation and Machine Building, chairman of the State Committee for Chemistry, president of the Academy, vice chairman of the State Economic Council, chairman of the Committee for Inventions and Discoveries, and minister of Higher and Specialized Education.

Consultants will be "a learned coun-

Soviet Cosmonaut Medal

Russia has struck a new "USSR Pilot-Cosmonaut" medal which will be awarded to Soviet citizens making "outstanding flights into space." Design on silver medal features globe girdled by a satellite in orbit.

Solid Boosters

El Segundo, Calif.—Projected capabilities for large solid propellant boosters were outlined in a two-day session before the President's science and advisory committee's ad hoc booster panel which convened here at Aerospace Corp. for presentations by Aerojet-General, Grand Central Rocket Co., Inc., Rocketdyne Division of North American Aviation, Thiokol Chemical Corp., and United Technology Corp.

Ad hoc booster panel members appointed by Dr. Jerome B. Weisner, special assistant to the President for science and technology, included:

- **Dr. Frank Long (chairman), Cornell University.**
- **Allen F. Donovan, Aerospace Corp.**
- **Dr. Howard W. Emmons, Harvard University.**
- **Dr. Donald F. Hornig, Princeton University.**
- **Dr. John F. Kincaid, Institute of Defense Analysis.**
- **Dr. Charles C. Lauritsen, California Institute of Technology.**
- **Dr. Frank T. McClure, Applied Physics Laboratory.**
- **Dr. Ruben F. Mettler, Space Technology Laboratories.**
- **Dr. Allen E. Puckett, Hughes Aircraft Co.**

cil consisting of prominent scientists representing different branches of science and engineering and heads of leading research establishments."

Committee will select "scientific councils" to work on specific problems.

Soviet Academy, according to the report, "will retain scientific and methodological instruction" responsibility. It will also "give more extensive assistance to Republic-level scientific academies, train scientific specialists and establish contacts with foreign institutions."

Missile Contractor Insurance Studied

Washington—Extent to which the federal government should insure contractors against damages resulting from missile accidents will be aired in a new National Aeronautics and Space Administration study.

Outcome of the investigation will be a bill expected to undergo hearings soon by the Senate Aeronautical and Space Sciences Committee.

NASA launched the study after its original indemnity bill ran into heavy criticism by members of the Senate space committee at a hearing on May 16. Sen. Clinton P. Anderson (D.-N. M.) expressed reservations about NASA's recommendation to make the government liable for an unlimited amount of damages.

He also noted that the NASA proposal did not require the contractor to carry private insurance on hazardous work to offset the government's risk.

NASA Administrator James E. Webb and General Counsel John A. Johnson argued that the agency was asking only for the same indemnity the government furnishes to Pentagon contractors.

Webb said without federal indemnity contractors either are unwilling to undertake hazardous NASA projects at all or add a considerable amount to the contract price to cover the high cost of private insurance. Webb said it was more practical for the government to protect contractors directly.

However, after Sen. Anderson and several other senators on the space committee attacked the indemnity bill proposed by NASA, Webb agreed to draft a revised indemnity measure. The bill NASA will submit to the Senate after this new study is expected to set limits on federal indemnity and require the contractor to acquire private insurance to cover part of his risk.

NASA lawyers are studying the Price-Anderson Act which provides indemnity for contractors working on federal atomic energy projects. They are expected to borrow liberally from the act in drafting the new indemnity bill.

Master Blueprint Is Proposed for Space

Washington – Executive agency should be established to draft and direct a master plan for U.S. civilian and military space programs, according to a staff study just released by the House Science and Astronautics Committee.

The study said the U.S. space effort needs "a top level organization to act as an executive agent for the President" and a "clearer definition" of the relationship between the Defense Department and the National Aeronautics and Space Administration.

Capt. Howard J. Silberstein, technical consultant to the House space committee, submitted these and other recommendations to committee chairman Overton Brooks (D.-La.) Dec. 30, 1960. But his report was released only recently by the committee.

Silberstein contended that under the present space administrative organization no one is charged with drafting objectives and then issuing reports for each agency on their efforts to achieve these goals. He would give this job to a space management office under the President.

The report also recommended two military space offices: one to provide over-all direction and coordination of the Pentagon's space program, including research and development functions; the other to direct space operations in the field.

High Altitude Chamber To Train Space Crews

High altitude chamber designed to simulate noise, vibration, heat, humidity and altitude of the space environment is being constructed in Seattle for the Boeing Co.'s Bioastronautics Section.

The $110,000 company-financed facility is being built by Vacudyne Corp. for use in Boeing 707 aircrew and general space crew indoctrination. Company expects to start using the chamber later this month.

The test section, 10-ft. wide, 8-ft. high and 22-ft. long, will accommodate 10 crewmen simultaneously. Unique feature, according to Vacudyne, will be the ability to simulate rapid decompression and to control decompression and time to go from a rapid to an explosive decompression in microseconds.

Vacudyne says the chamber will go to simulated altitudes of beyond 200,000 ft. in 15 min., and will have temperature variations from −40F to 220F.

Boeing, which is Dyna-Soar vehicle contractor, plans to use the facility to assess space suits, life support equipment and closed ecological systems, and to study stress limits.

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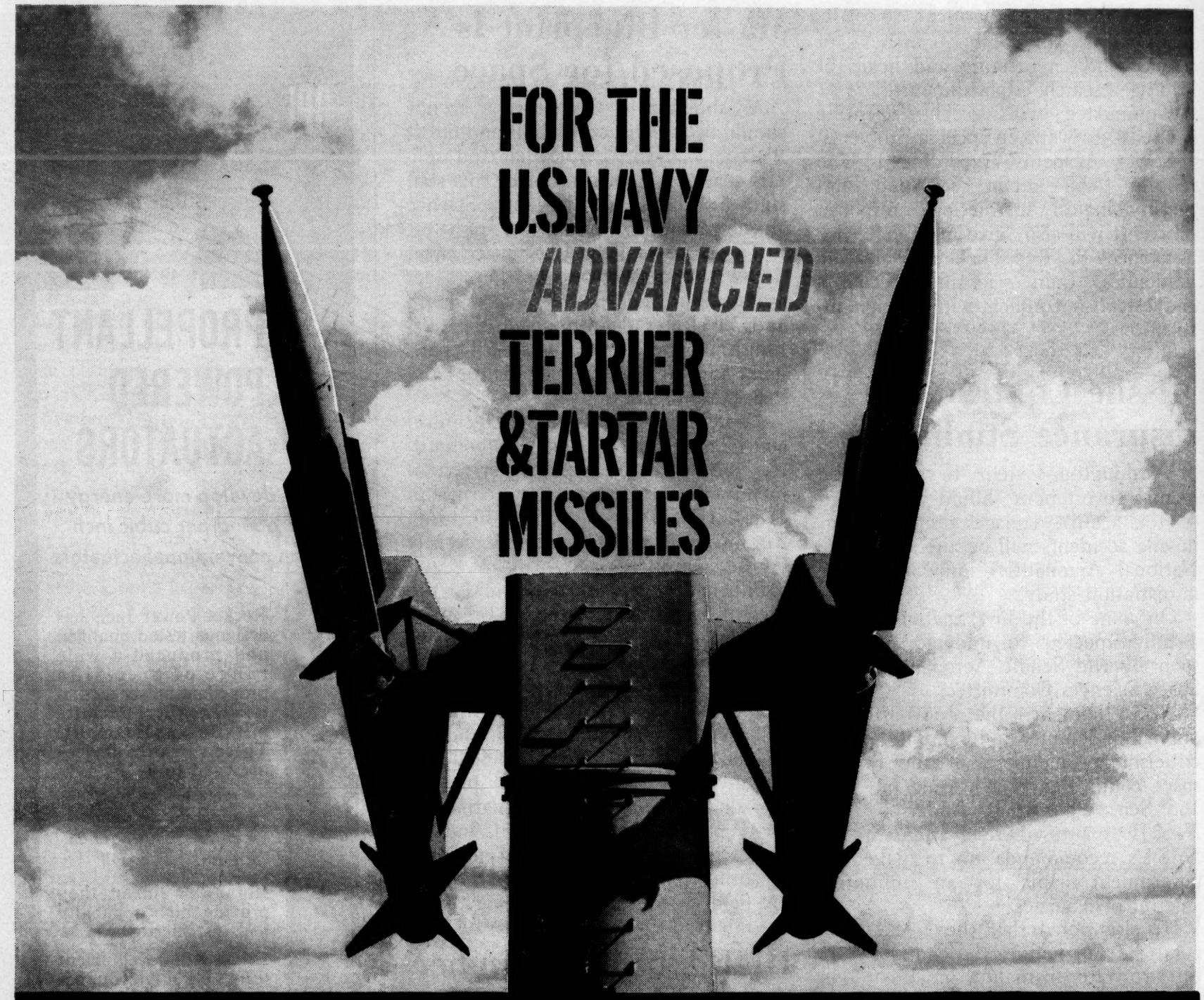

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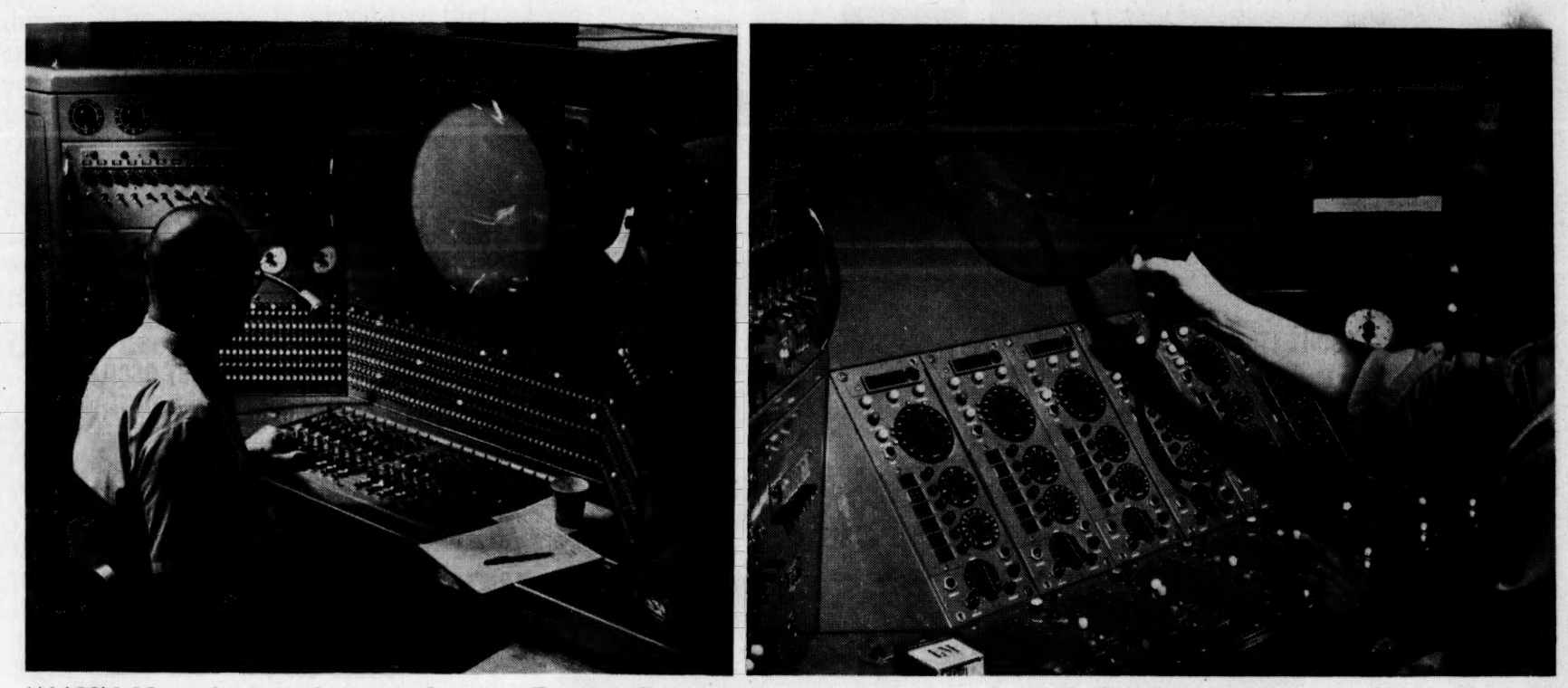

AN/GSN-11 semi-automatic terminal area traffic control system, soon to undergo test by Federal Aviation Agency, was developed by Air Force to provide precise sequencing of aircraft returning to base, to avoid landing delays. Operator at monitor console (left) supervises entire operation of up to 18 aircraft under GSN-11 control, assigns landing times and alters sequence in event of an emergency. Operator at each of three arrival consoles (right) is responsible for acquisition and control of up to six aircraft.

FAA Will Test GSN-11 Terminal Control

By Philip J. Klass

Cincinnati—Air Force's AN/GSN-11 semi-automatic traffic control system, designed to provide precise sequencing of aircraft approaching an airfield for landing, will be shipped this month to the National Aviation Facilities Experimental Center in Atlantic City for flight evaluation tests.

The GSN-11 is designed to handle up to 18 approaching aircraft simultaneously, providing each pilot with voice commands which tell him what his aircraft heading and rate-of-descent/altitude should be to bring the aircraft into final approach position at prescribed intervals. System also provides for sequencing up to six aircraft departures simultaneously.

The present equipment is a third-generation descendant of the experimental GSN-3, better known as Volscan, developed and built eight years ago by the Air Force Cambridge Research Laboratories (AFCRL). The GSN-11, as well as three interim GSN-3 prototypes, was built here by Avco Electronics and Ordnance Division under USAF contract.

During the past year, the GSN-11 has been under evaluation here using aircraft radar simulators, with more than 10,000 simulated approaches made during this period. In simulated runs made with 40-sec. landing intervals, equivalent to landing 90 aircraft/hour, 87% of the aircraft arrived at the approach gate within 12 sec. of their assigned time slot, according to Ben Greene, chief of AFCRL's Control Sciences Laboratory.

This occasionally resulted in aircraft separations which were less than those prescribed for civil standards, but which are acceptable for military operations, according to Greene. By reducing the capacity to 60 aircraft/hour (60-sec. landing intervals), the operation would be "completely safe," according to Greene. This figure is twice the peak traffic handled by the best of today's large civil airports under IFR conditions.

Avco and Greene believe the GSN-11 could prove a valuable system for larger civil airports. The GSN-11 is in competition with the data processing system which the FAA is now developing for both en route and terminal area traffic control, but its proponents point out that it is a third-generation equipment which already has undergone extensive testing and debugging of basic principles.

How It Operates

The GSN-11 is a computer-data processing and display system which obtains its input information from surveillance radar(s), such as the AN/FPS-34. When an aircraft approaches the terminal area, roughly 90 mi. out, the pilot requests a landing assignment and identifies his aircraft on the GSN-11 radar console scopes by means of a maneuver or using his radar beacon. A human operator at one of three arrival consoles is assigned to the aircraft and attaches a tracking gate to its radar blip, using a "light gun." (See photo above.) The tracking gate continuously follows the aircraft's blip, providing the computer with information as to its position and velocity. Each of three arrival console operators in the GSN-11 can handle up to six aircraft.

Based on the new arrival's position, altitude and speed, the GSN-11 computer promptly calculates the earliest possible time that the aircraft could arrive at the approach gate (where it begins its ILS or GCA approach) if it were to fly a straight-in path. This is displayed by means of lights on the panel of the monitor console operator. He examines his panel and if this earliest-possible time slot is open, he assigns it to the new aircraft.

If the earliest-possible slot already has been given to another aircraft, the human operator assigns the new arrival the next earliest available position. The GSN-11 then computes what path-stretching maneuver is required to delay the new arrival sufficiently to bring it into the approach gate at the assigned time. Simultaneously, the computer calculates what heading the new aircraft must take up to put it onto the required flight path.

This required heading is transmitted automatically to the aircraft by means of an automatic voice relay (AVR),

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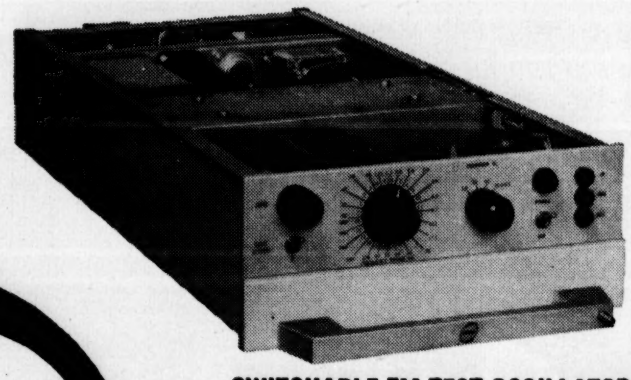

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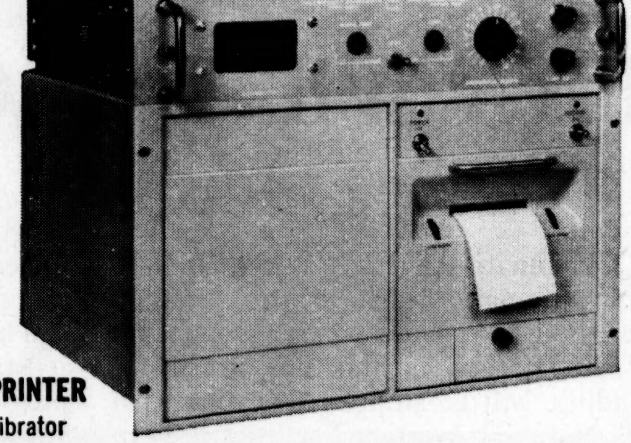

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which uses prerecorded words and phrases stored on rotating magnetic drums. The message is pieced together and transmitted without human intervention under computer control, but can be monitored by human operators. (For details on the automatic voice relay, developed by Cook Research Laboratories, see AVIATION WEEK, July 16, 1956, p. 89.) Operation of the automatic voice relay is monitored by controllers at the relay console.

Closed Loop

The tracking gate which follows the aircraft's radar blip keeps the GSN-11 computer continuously apprised of the path the aircraft is actually flying. The computer continuously calculates the time that this would bring the aircraft into the approach gate and compares it with the assigned time slot. If the aircraft is deviating from its assigned flight path, the computer calculates a new (longer or shorter) path needed to bring it back on schedule and automatically transmits the new heading to the aircraft.

The vertical profile of the aircraft is scheduled on the basis of a uniform rate-of-descent which will bring it from its original altitude down to the required altitude at the approach gate. This is computed at the same time that the required aircraft flight path heading is determined, and transmitted by automatic voice relay.

When the computer schedule indicates that an aircraft should have reached a new 1,000-ft. increment of altitude in its descent, the GSN-11 automatically transmits a message to the pilot, via the voice relay, giving him his new altitude check-point. Lacking a height-finder radar input, the GSN-11 cannot directly monitor the vertical profile being flown and must depend upon the pilot to alert the arrival console operator if he has deviated significantly from the scheduled rate-of-descent.

Approach Gate

As the aircraft nears the approach gate, leaving less time for corrective maneuvers, the precision of the path the pilot must fly increases. For this reason the rate at which heading information is transmitted to the pilot automatically is increased.

An arrival console operator can intervene manually at any time, as can the monitor console operator, who supervises the entire operation by means of a large radar scope and appropriate display lights. If, for example, an unsafe situation appears to be developing, the arrival or monitor console operator need only decide which aircraft should be diverted, push an appropriate button and turn a knob to the new heading he wants the airplane to take up. The

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The Laboratory also developed the Navy's POLARIS guidance system. Studies for NASA are currently being carried out.

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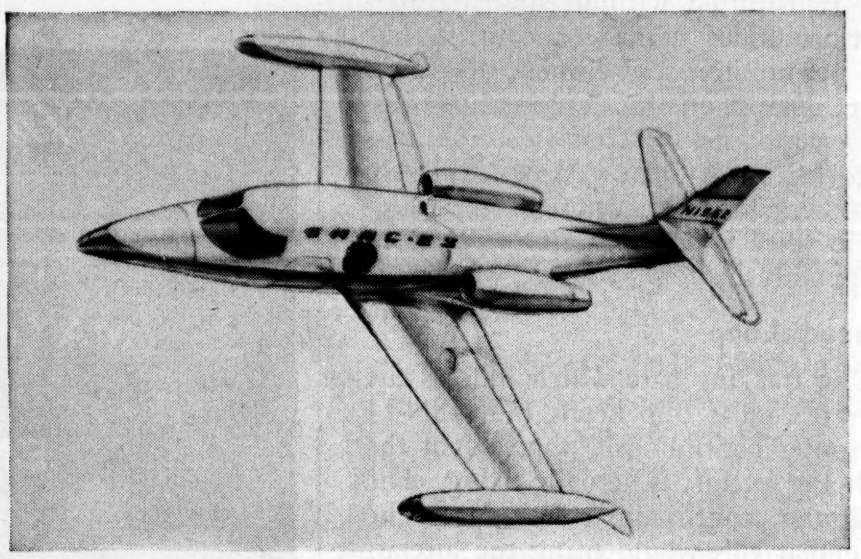
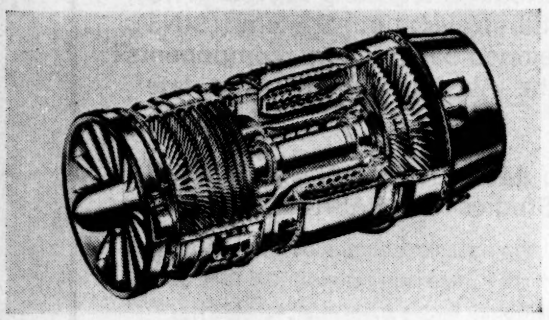


Swiss-American SAAC 23

CJ610 Selected to Power Executive Jet Aircraft

LYNN, Mass.—Twin General Electric CJ610 turbojet engines will provide power for new business aircraft recently announced by Aero Commander Inc., and Swiss-American Aviation Corp.



Simplicity of CJ610 design, which is nearly identical to the proven military J85, provides easy inspection, maintenance and disassembly.

The two six-to-eight place executive aircraft will bring Jet Age speed and improved range to the expanding corporate aircraft market.

Aero Commander's Model 1121, known as the "Jet Commander," and Swiss-American's SAAC 23, can cruise over the weather at speeds in excess of 500 mph. Their CJ610 engines, developed specifically for use in business aircraft, will enable both to operate from the same fields as those used by present-day propellor-driven aircraft.

Named as powerplant for the "Jet Commander," the CJ610-1 version produces 2850 lbs guaranteed thrust. The CJ610-2B, to be used in the SAAC 23, produces 2400 lbs guaranteed thrust.

Both versions are compact in design and measure 39.7 inches in length and 17.7 inches in diameter. Both will be FAA certified in 1961.

The CJ610-2B is also being used in studies by Israel Aircraft Industries as the powerplant for its B-101C executive jet.

Price of the CJ610 engines is lower than that of any comparable engines on the market.

The high performance CJ610 turbojet is one of the commercial derivatives of the proven military J85. With a history of nearly 30,000 test hours, the J85 has demonstrated versatility and reliability as the powerplant for Northrop's operational T-38 "Talon" trainer, McDonnell's GAM-72 "Quail" missile, now operational with the Strategic Air Command, Radioplane's Q4B supersonic target drone, and the experimental VTOL X-14A.

For additional information on the CJ-610 write for Bulletin GED-4451.1.

Convair 880: Three speed records, 1200-hour

CINCINNATI, O.—The 615 mph Convair 880 jet airliner helped three airlines set commercial speed records during its first year of scheduled service ending May 15, 1961.

The first speed record was claimed by Delta Air Lines during delivery of their initial 880. The aircraft raced the 2359 miles from San Diego to Miami in 3 hours 31 minutes to set a southern transcontinental speed mark. Average speed was 655 mph.

Last fall, an 880 destined for Northeast Airlines cut the 2730-mile "corner to corner" transcontinental record from San Diego to Boston to 4 hours, 10 minutes.

Most recently, Trans World Airlines joined the record setters when an 880 Superjet Flight set a commercial record of 2 hours, 57 minutes for the 1920 miles between San Francisco and Chicago. Scheduled time: 3 hours, 35 minutes.

In another first year development, the FAA recently granted Delta Air Lines a 1200-hour Time Between Overhaul for the General Electric CJ-805-3 turbojet engines powering the Delta 880 fleet. The authorization also included a TBO of 1500 hours for engine accessories and controls. The increase

TWA 880 Superjet hit 720 mph to set 1920-mile San Francisco-Chicago speed mark.

NEWS

A report about progress in research and products from the Flight Propulsion Division of the General Electric Company

30-Kw Plasmajet Engine Tested Successfully

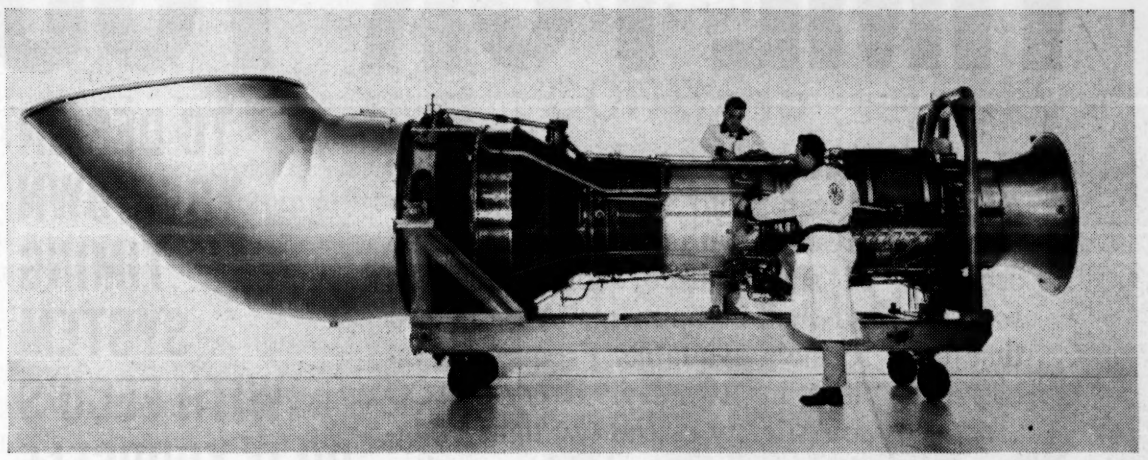
CINCINNATI, O.—A 30-Kw arc jet engine for space propulsion has successfully completed initial performance tests at General Electric's Flight Propulsion Laboratory.

Work on the engine is being performed for the National Aeronautics and Space Administration. This electric engine is designed to produce thrusts of the order of 0.5 lbs for extended periods of time, making it suitable for a number of functions in space.

Under another program—also being performed for NASA—General Electric is pinpointing the most attractive missions for this propulsion system, centering around lunar transfers, transfer to stationary satellite orbits and communication satellite installation functions. Power for this engine will be supplied by the SNAP VIII nuclear-turbogenerator system.

In principle, arc jets are similar to chemical rockets, except that the acceleration of mass is accomplished by an electrical energy input, rather than a chemical reaction. This allows the arc jet to operate at very high specific impulses, three to four times the value of chemical systems.

Because of its low propellant consumption, the electric power-propulsion system promises very significant increases in useful orbital payloads—with the boosters now under development.



Model 240 turboshaft is scheduled to power U.S. Maritime Administration 80-ton, 60-knot hydrofoil later this year. Dynamic Developments, Inc. is building the vessel.

Model 240 Engine Completes Tests; Goes to Grumman for MARAD Craft

CINCINNATI, O.—General Electric's Model 240 turboshaft engine, slated to power the U.S. Maritime Administration's 60-knot hydrofoil vessel in sea trials this summer, has completed qualification testing.

The engine produced over 18,000 shaft horsepower at 5500 rpm. All vibration levels were within design limits and turbine blade stresses were below limits for all normal operating conditions.

Following completion of the tests, the engine was shipped to Dynamic Developments, Inc., an affiliate of Grumman Aircraft Engineering Corp., at Babylon, N. Y. Dynamic Developments is under contract to deliver the 80-ton hydrofoil to MARAD this year.

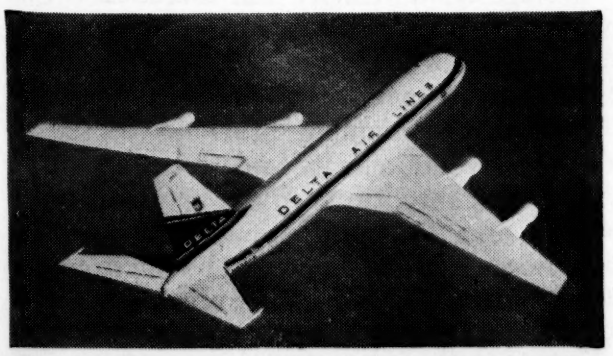
G.E.'s Model 240 engine is part of a complete power package the Company is offering for marine propulsion. The package includes main powerplant, transmission, and docking engine.

The basic Model 240 engine is a turboshaft version of G.E.'s proven CJ-805 commercial turbojet. The basic engine weighs approximately 6600 pounds, only one-tenth as much as similarly rated reciprocating engines and steam propulsion systems.

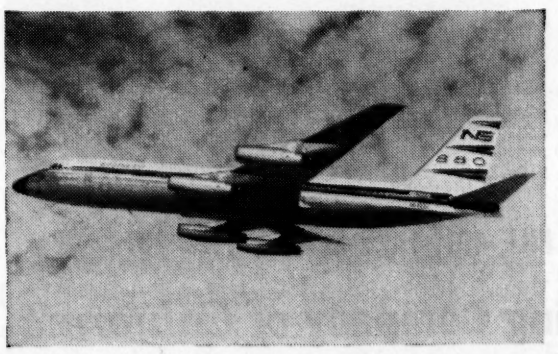
General Electric's test facilities at Evendale, Ohio, where the Model 240 passed qualification, includes three water brakes capable of measuring 27,000 shaft horsepower. The Model 240 tests represented the first time such a system has been used with a large turboshaft engine.

...engine TBO in first year

was granted in accordance with the FAA's Turbine Engine Time Control Program, which permits TBO extensions of 200 hours when engine shutdown rates of less than 1 per 10,000 flight hours are demonstrated.



Delta 880 averaged 655 mph, setting southern transcontinental speed record.



Northeast 880 cut "corner to corner" San Diego-Boston record to 4 hr, 10 min.

CJ-805-23C Certificated by FAA

CINCINNATI, O.—General Electric's CJ-805-23C aft-fan engine has been awarded Federal Aviation Type Certificate number 1E5.

The 16,100 pound thrust class CJ-805-23C will power the Sud Aviation Caravelle VII, scheduled to make its first flight in France late this year. General Electric has been flight testing a Caravelle with aft-fan engines installed since December, 1960.

FOR MORE INFORMATION

If you would like additional information on these G-E flight propulsion programs, write: General Electric Company, Section 206-28, Schenectady 5, N. Y.

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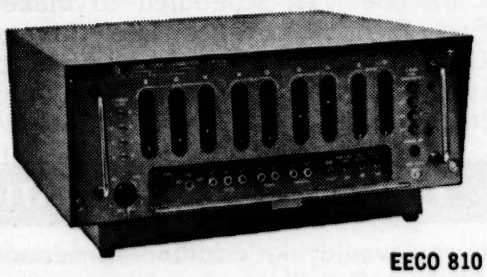
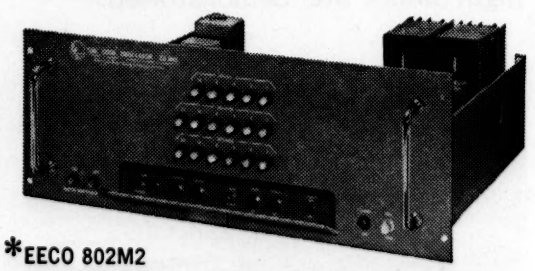
	Model Number	Serial Code Format	Time Indication	Code Frame Length (SEC)	Code Scan Rates (PPS)	Code Carrier Frequency (CPS)	Auxiliary Pulse Rates (PPS)	Price (f.o.b. Santa Ana)
	EECO 801	24-Bit, 24-hour, BCD	hours, minutes, seconds	1	25, 50, 100	1000	100K, 10K, 1K, 100, 50, 25, 10, 1	$7500
	EECO 802 (Eglin AFB and Patrick AFB)	17-Bit, 24-hour, Binary	hours, minutes, seconds	1	20, 100	1000	100K, 10K, 1K, 100, 20, 10, 1	$7000
		13-Bit, 24-hour, Binary	hours, minutes, ¼ minutes	15	1	1000		
*	EECO 802M2 (Atlantic Missile Range)	17-Bit, 24-hour, Binary	hours, minutes, seconds	1 20	20, 100 1	1000	100K, 10K, 1K, 100, 20, 10, 1	$7000
	EECO 803	20-Bit, 24-hour, BCD	hours, minutes, seconds	1	25	250	None	$7500
	EECO 804	20-Bit, 24-hour, BCD	hours, minutes, seconds	1	25	100 (mixed with 1000)	1 1pp10s 1ppm	$7925
	EECO 810	36-Bit, 365-day, BCD (4 extra bits available for identification data)	days, hours, minutes, seconds	1	100	1000	None	$10,100
	EECO 810M1 (IRIG Member C Format Modified)	23-Bit, 365-day, BCD (4 extra bits available for identification data)	days, hours, minutes, seconds	60	2	1000	10K, 1K, 100 10, 1, 1ppm, 1pphr	$10,100

Model Number		Price (f.o.b. Santa Ana)
EECO 860	**Neon Distribution Amplifier.** Accepts up to 3 pulse-width modulated signals from a time code generator to provide signals to drive camera neon lamps in remote sites.	$2500
EECO 861	**Relay Driver.** Accepts up to seven separate pulse trains or pulse-width modulated codes from a time code generator. Seven separate mercury-wetted relay contact closures to control external equipment.	$1200
EECO 863	**Line Driver** for transmitting 12 channels of carrier modulated timing signals over long distances.	$1975
EECO 27096	**Scanner Unit.** Accepts outputs from the EECO 802M1. Produces two 17-bit modified time-of-day codes in the format of the Atlantic Missile Range and one pulse rate output.	$5775

Compatible automatic magnetic tape search equipment is available for operation with each EECO time code generator.



EECO 810



*EECO 802M2

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EE 1-29

necessary voice instruction automatically is transmitted to the pilot over the automatic voice relay, and this emergency command is given first priority over routine messages.

Additionally, the human operators all have the conventional two-way radio channels for direct operator-to-pilot voice communications.

Approach Delay Maneuvers

One of the many new features which the GSN-11 incorporates is the choice of three possible path-stretching maneuvers where the previous GSN-3s offered only one:

- **Arc-cosine path,** the one used in the GSN-3, is a curved flight path in which the radius of curvature of the path is roughly proportional to the amount of time that must be consumed.
- **Dog-leg path** has two advantages over the arc-cosine: the aircraft are flying straight-line paths, except for the one turn, which reduces pilot work-load and frequency with which new headings must be transmitted. Also, as the aircraft near the approach gate, they are all flying straight-in paths rather than curved ones, which eliminates aircraft crossings.
- **Teardrop path,** especially designed for jet penetration approaches, allows aircraft to be cleared at altitude across a radio beacon/navaid on the airfield, on a preassigned heading. The aircraft then is acquired by the GSN-11 which computes shape of teardrop path needed to consume required amount of time.

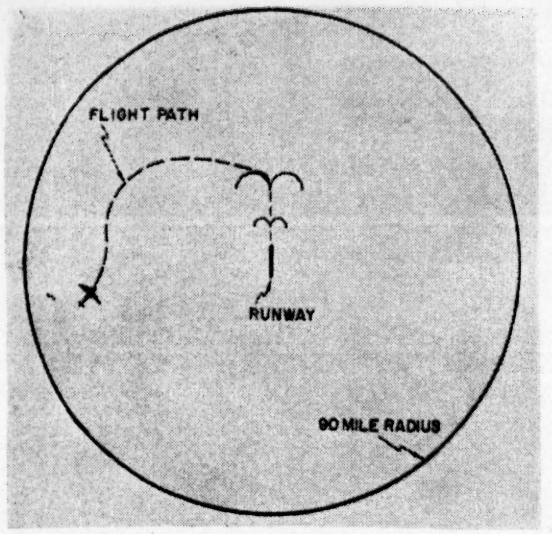
Airspace in the terminal area which cannot be used for approach, because of obstacles or other traffic, can be blocked off and made unavailable to computer for path-stretching maneuvers.

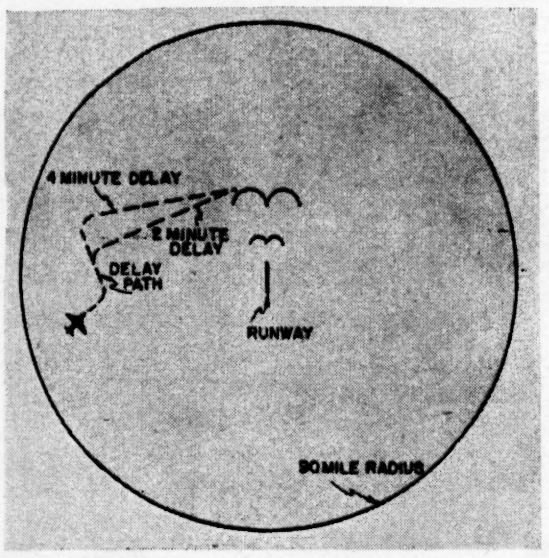
Simultaneous Approach

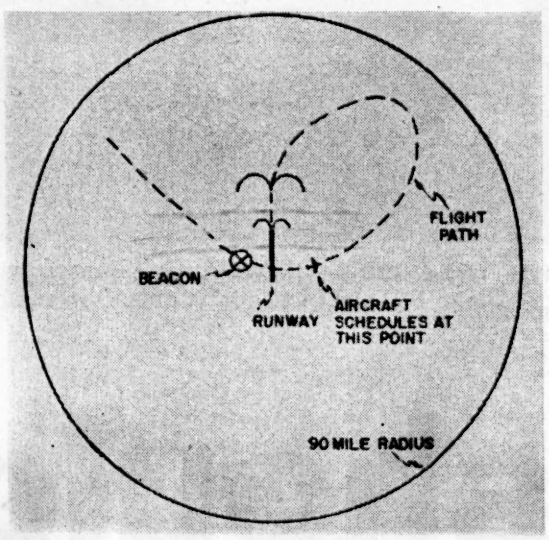
The GSN-11 can provide teardrop path stretching for jet fighter aircraft, while simultaneously providing arc-cosine or dog-leg paths for slower piston-engine aircraft. The equipment also can be operated to provide for approaches to three different airfields in a terminal area, or to permit simultaneous approaches to parallel runways on a single airfield.

One of the shortcomings of the previous GSN-3 was its use of a single average wind velocity and direction for aircraft at all altitudes in computing earliest possible time of arrival and subsequent path-stretching maneuvers. The new equipment provides for setting in wind velocity and direction for five different altitude layers between sea level and 44,000 ft.

Because there may not be sufficient airspace available in a terminal area to provide separate stretch-path areas fo aircraft of widely different speeds, the system permits faster aircraft to overtake and pass slower ones by means of







THREE path-stretching maneuvers can be provided to different aircraft simultaneously by the GSN-11, where its predecessor GSN-3 permitted only one. The arc-cosine path (top) is suited to slower aircraft, while the tear-drop (bottom) was devised for military jets operating off established airways. New dog-leg (center) path simplifies pilot's job and reduces radio load.

altitude separation. But as the aircraft near the approach gate, where their glide slopes converge, the computer automatically bans aircraft passing.

The operators at the arrival and monitor consoles have several means of identifying individual aircraft blips on their scopes. One is the visual display of Alpha-numeric characters alongside each blip on the radar scope. Another is a "light gun" which, when aimed at the radar blip in question, causes a light which is alongside the appropriate aircraft flight progress strip to flash on.

If the arrival console controller wishes to establish the relative altitude of each aircraft on the scope, to determine whether two approaching blips present a collision hazard, he need only push a button to display an "altitude strobe"—radial lines from the center of the scope, each pointing to one of the blips and of a length proportional to its aircraft's scheduled altitude.

The GSN-11 is considerably more sophisticated than an operational system to permit experimentation and operational changes, according to Robert Meuleman supervisor of Avco's electronic system design engineering group. The system includes considerable redundancy for increased reliability and extensive built-in test and trouble-shooting equipment.

In small production quantities of five to 10 systems, an operational equipment is expected to cost between $1 million and $2 million each.

GSN-11's Future

Several factors may determine whether the GSN-11 becomes the first of a series of operational terminal area semi-automatic traffic control systems installed at large military air bases and perhaps at larger civil airports, or the last of a family of early pioneers in the business of traffic control.

The results of the FAA tests at NAFEC in Atlantic City, in which the equipment will be subjected to control of live aircraft, are expected to influence the Air Force's decision on whether or not to buy additional systems.

The Air Force now has nearly a dozen major high-density air terminals around the globe where such a GSN-11 type system could be economically justified.

Both the Strategic Air Command and the Air Defense Command have shown interest in the GSN-11 for some of their major air bases. But because emphasis is shifting away from manned aircraft, and because it probably would be 1964 or later before additional GSN-11s could be built, installed and operational, the Air Force may decide not to make the investment for SAC and ADC bases.

For civil use, the GSN-11 faces competition not only from the FAA's own semi-automatic traffic control system development, but from newer digital computer techniques. Although AFCRL's Greene says that studies indicate that the analog computer techniques used in the GSN-11 are the least expensive and most effective way to handle the terminal area problem, the proponents of digital techniques point out that they have far greater flexibility in being able to adapt to new situations and operating procedures.

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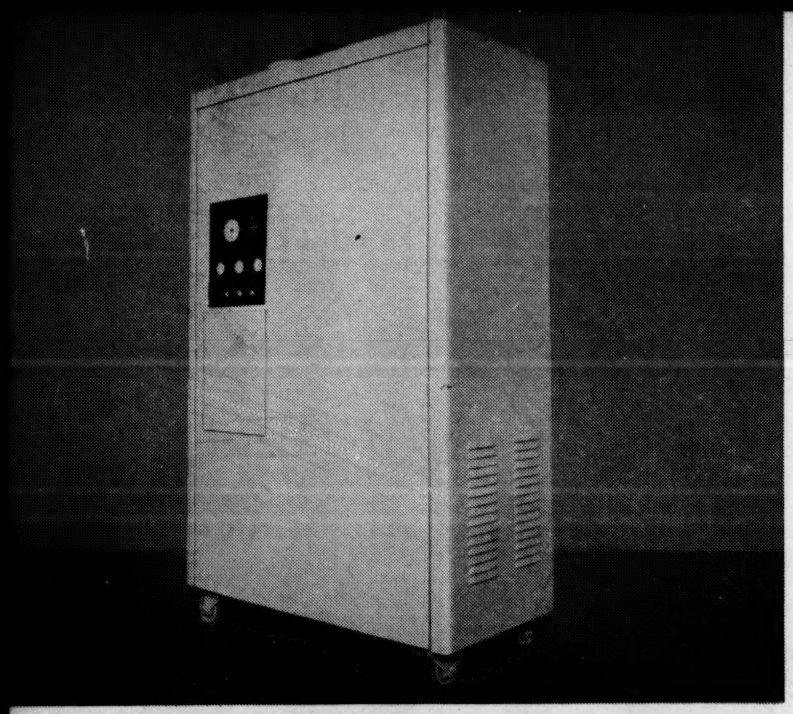
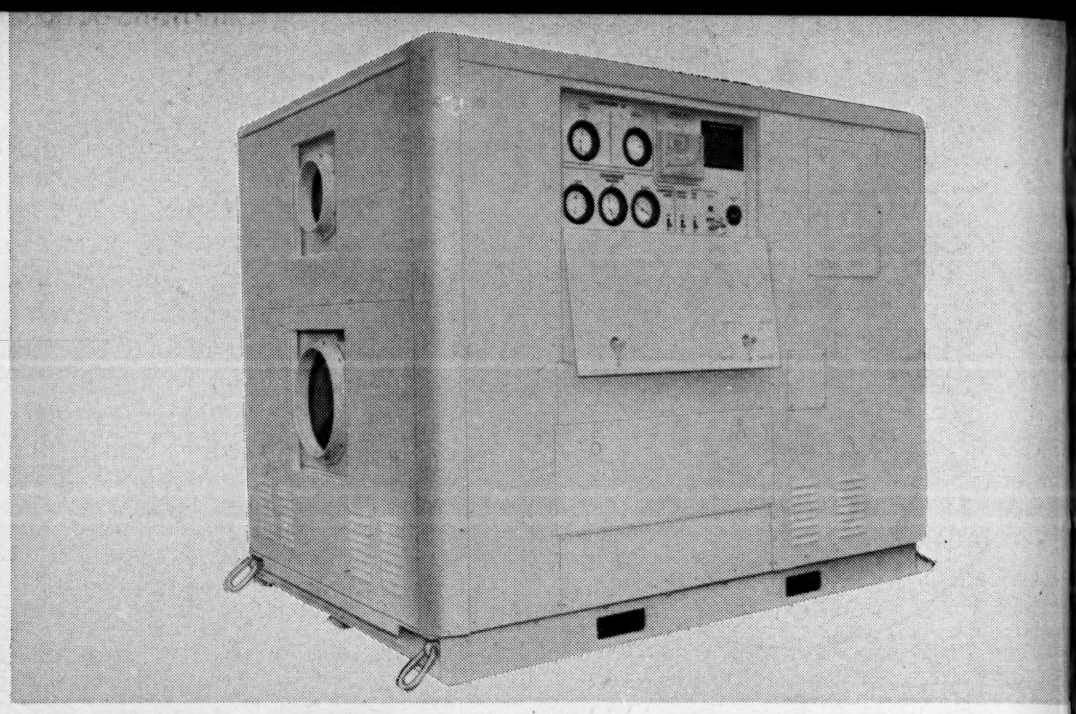


OR THE MINUTEMAN PROGRAM—An instrument cooling pack. elivers 25 lbs/min of air at 37°F, and 2.5 psig. for R & D testing.



FOR THE TITAN I PROGRAM—An air-conditioner which simultaneously heats and cools guidance control gear in nose cone and lox sections of the missile, while in the silo.

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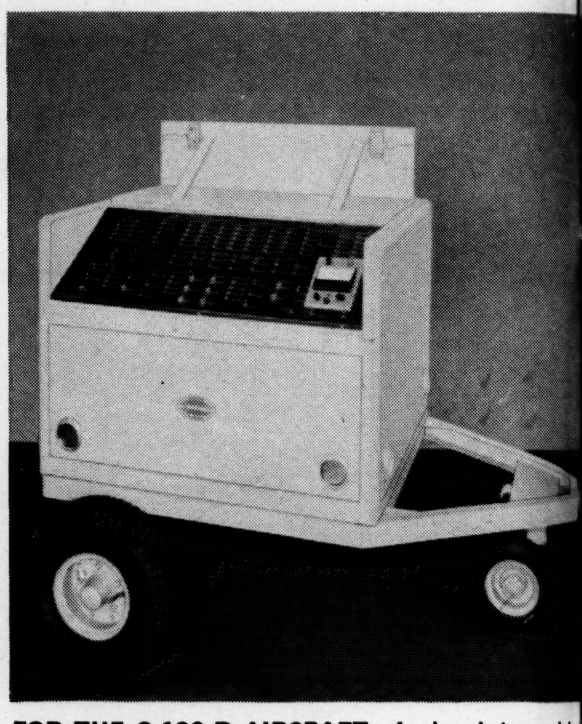
FOR THE NAVY T-56 & T-58 ENGINES—A complete jet fuel control test stand. Supplies fuel flows up to 6,500 bs/hr at 1,500 psig. Has controllable air-flow temperature range from −65 to +300°F, accurate to ±1°F.



FOR THE C-130-B AIRCRAFT—A simulator whic can make 100 electrical circuit checks in minutes

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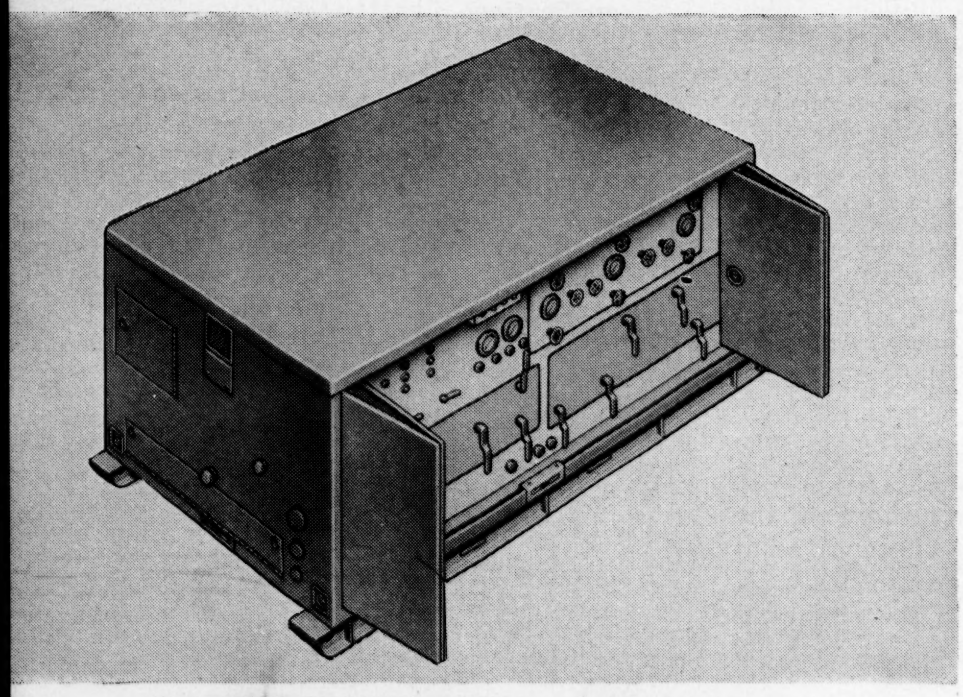
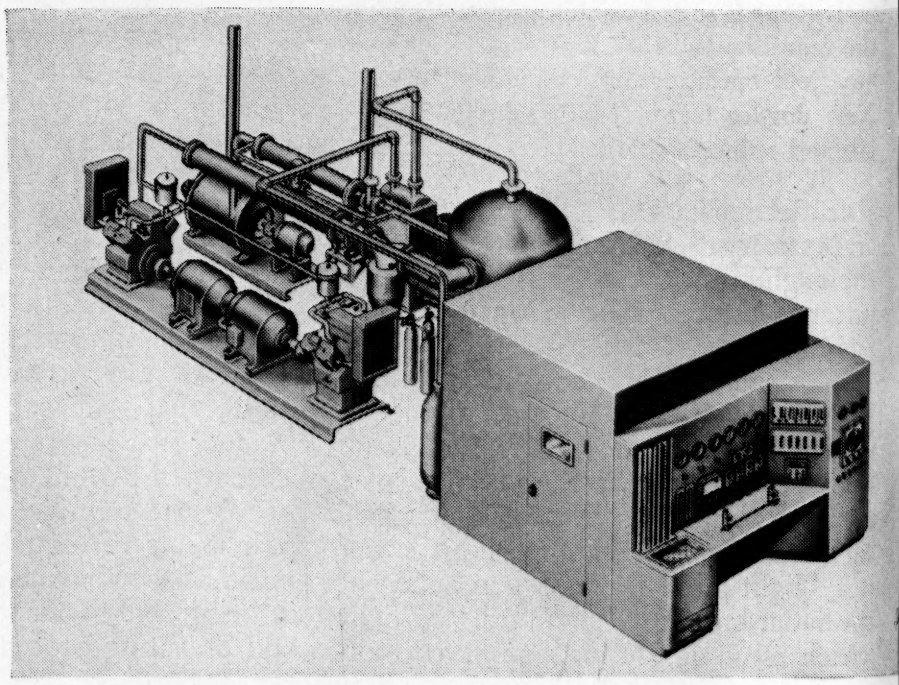
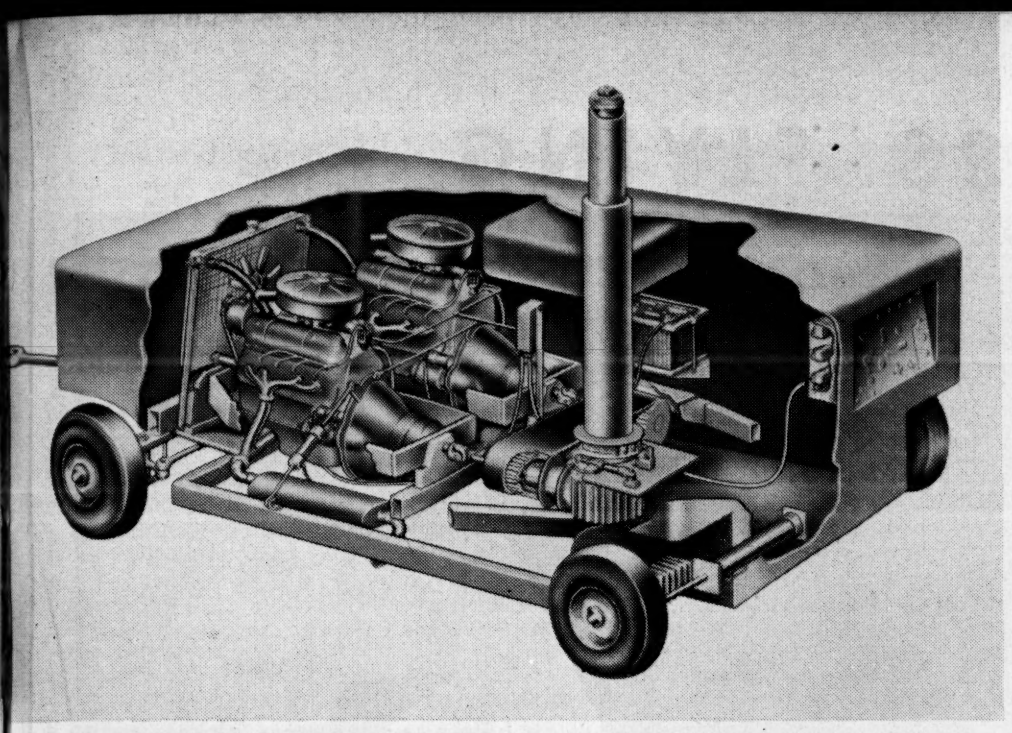
Two facts you should k



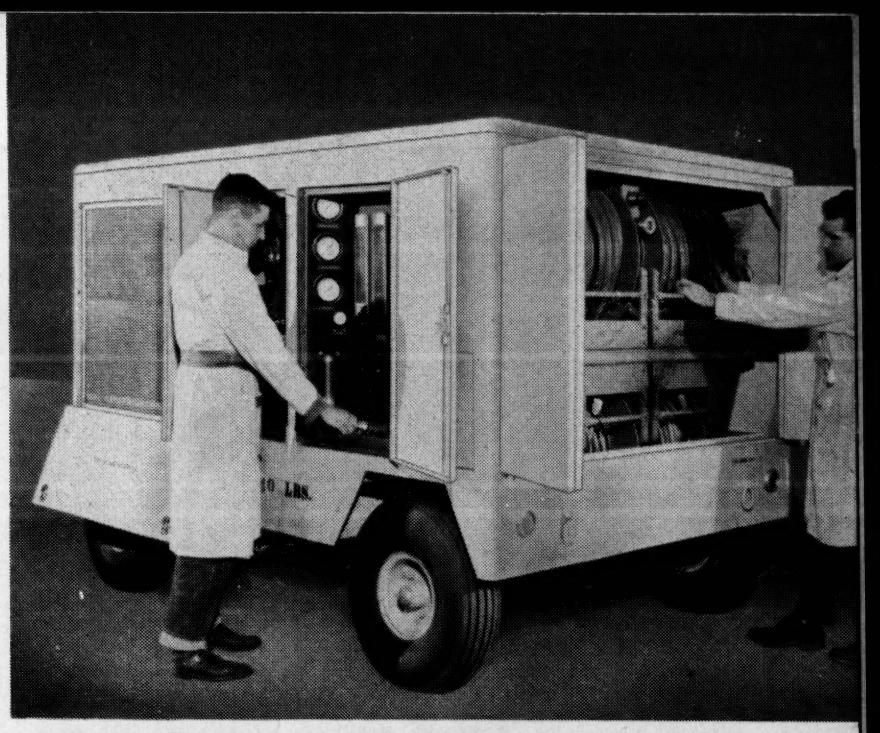
FOR THE TITAN II PROGRAM—A pumping and metering unit for transfer of propellant fuel and oxidizer.



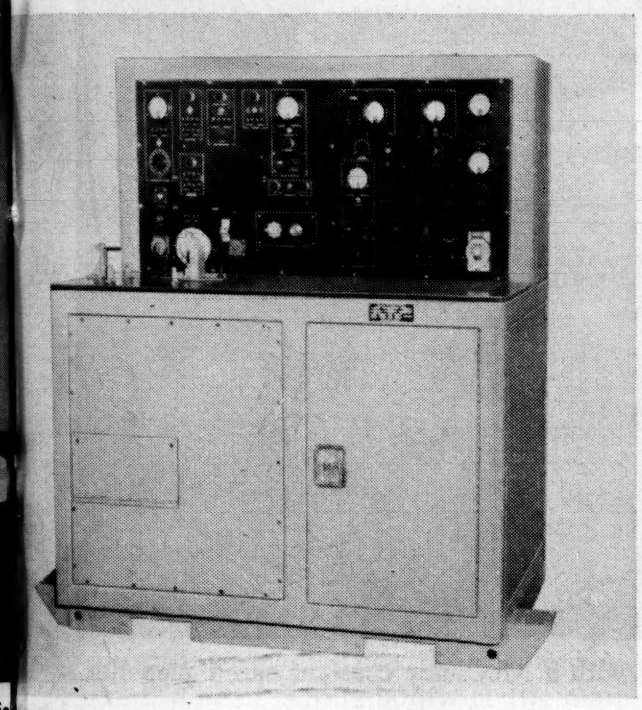
FOR THE F-104—A pneumatic test stand. Simulates flight conditions to functionally check the plane's air-conditioning system during overhaul.



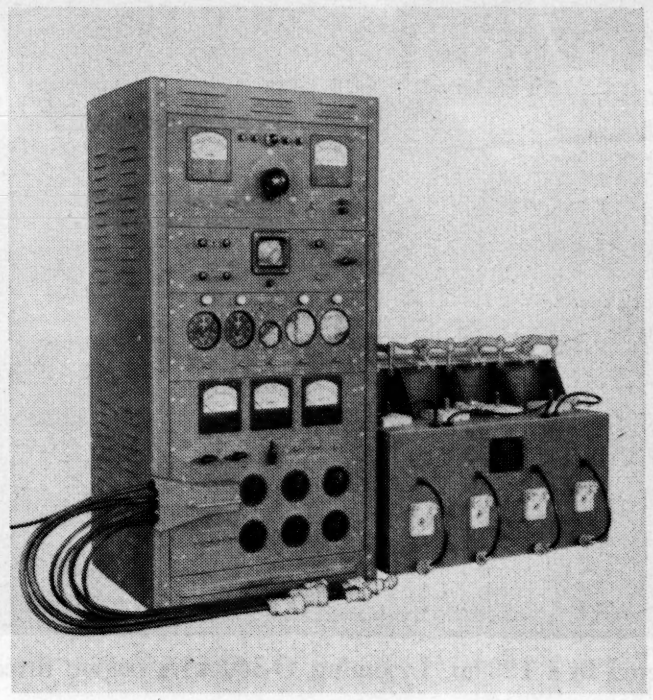
FOR AN ADVANCED TURBOJET ENGINE—A new mobile starter system. Engages directly with engine's gearbox. Offers a wide range of starting torques and speeds.



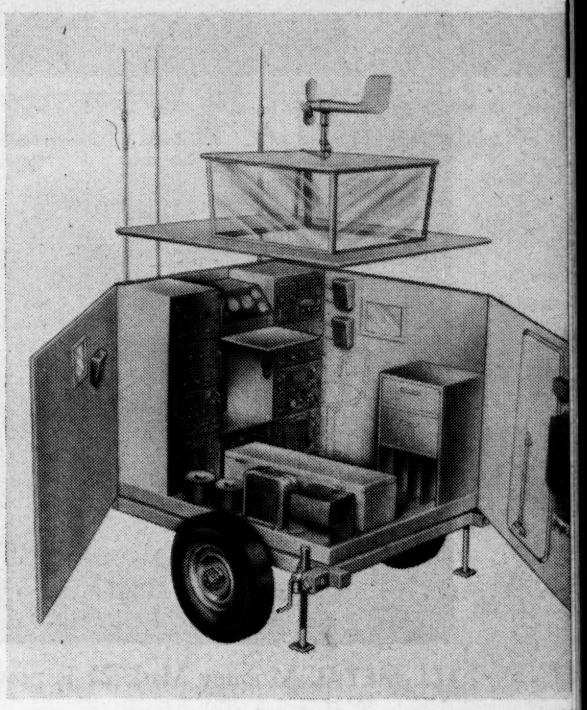
FOR AN ADVANCED FALCON MISSILE—An automatic liquid conditioner. Cools or heats electronic components, during ground checkout.



FOR THE B-58—A test stand for functional check out of the plane's temperature-control components.



FOR THE AIR FORCE AND NAVY—A propeller synchronizer test stand for 2- and 4-engine aircraft.



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GROUND SUPPORT EQUIPMENT

ALL-METAL Mooney Mark 21 is powered by a 180-hp. Lycoming O-360-A1A engine fitted with a McCauley constant speed propeller.

Aviation Week Pilot Report:

Mooney Mark 21 Shows Performance Gains

By Andy Keil

New York—Improved flight characteristics of the all-metal Mark 21 is an unexpected boon for Mooney Aircraft Co. and adds justification to its switch from the wood-and-metal construction of the Mark 20.

Mooney engineers believed that conversion from the wooden wing and empennage of the Mark 20 to the all-metal construction of the Mark 21 would have no influence on the performance of the new aircraft inasmuch as the physical and aerodynamic dimensions were identical. With the conversion implemented only to eliminate production bottlenecks, the improved slow-flying and stall characteristics as well as the smoother taxiing performance of the Mark 21 are attributed by Mooney engineers to the stiffness of the all-metal structure.

The new Mooney Mark 21, first design details of which were reported by AVIATION WEEK Jan. 16, is a four-place, low-wing aircraft 8 ft. 4.5 in. high and 23 ft. 2 in. long, powered by a 180-hp. Lycoming O-360-A1A high-compression engine designed for 91/98 (recommended 100/130) octane gasoline, with a McCauley constant speed 74-in. aluminum alloy propeller.

Fuselage Design

With a small dorsal fin marking the only difference in appearance from the Mark 20, the all-metal Mooney fuselage consists of welded chrome-molybdenum steel tube frame with aluminum skin flush riveted thereon. The fuselage tail cone section has been redesigned of monocoque construction for added strength, with a spring-steel tail skid for protection against a tail-low landing, and a tiedown ring attached to the lower section of the tail cone rear bulkhead.

The luggage compartment, capable of holding 120 lb. of baggage, is accessible from the inside or outside from a right-hand door aft of the cabin door. The luggage door is made both air and water tight by a full length piano hinge, rounded corners and rubber mounting.

Empennage construction is similar to the wing in that it is fully cantilevered with a single main "Z" spar and with the metal skin stretch-formed and wrapped to eliminate any skin laps in a span-wise direction. Flush rivets are used wherever necessary to eliminate drag.

The 7.9 sq. ft. vertical stabilizer is constructed with an offset of 1.0 deg. to compensate for torque; the horizontal stabilizer has 21.5 sq. ft. area with the elevator and rudder 12 sq. ft. and 5.01 sq. ft. in area respectively. Rotation of the pilot's trim wheel moves the tail cone and empennage via a torque tube extended back to a screw-jack assembly. Movement of the entire tail empennage eliminates the drag of the standard trim tab and keeps the vertical stabilizer perpendicular to, and the horizontal stabilizer lined up with, the line of flight.

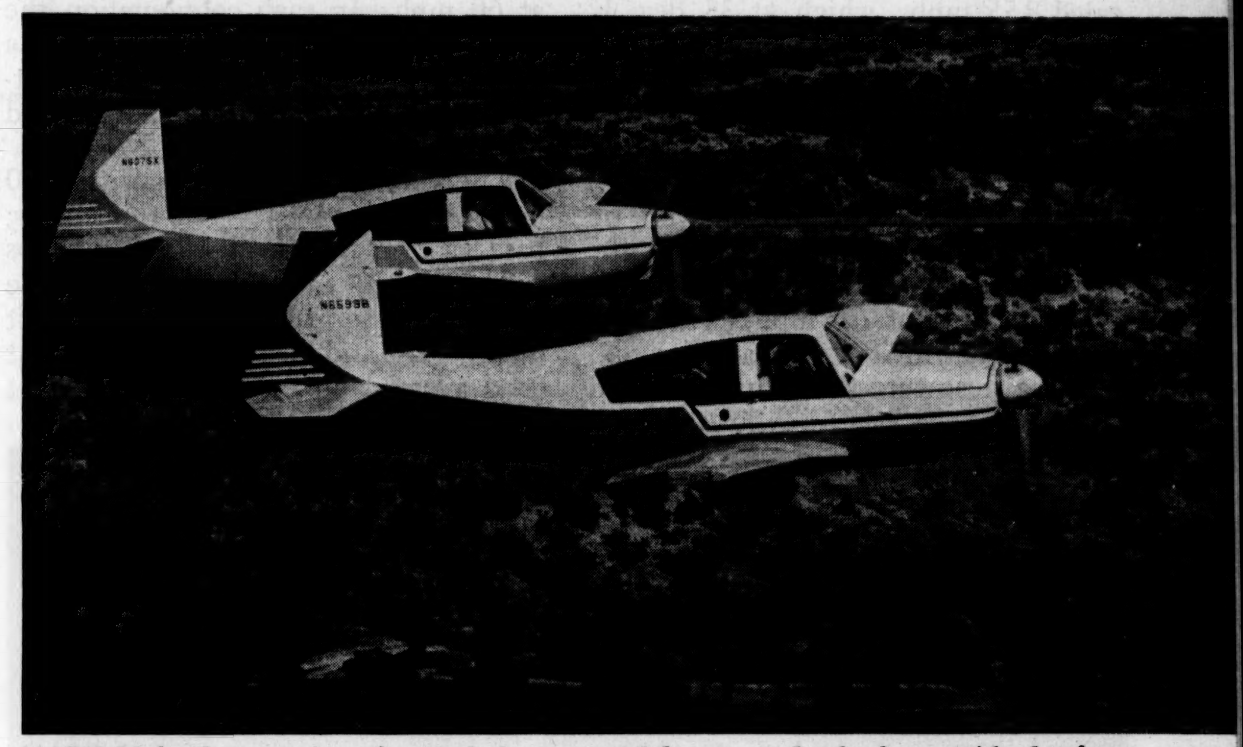
This modification is also responsible for positive rudder and elevator control right through the stalling speed range.

The new metal wing, with a span of 35 ft. and a total area of 167 sq. ft., is built as a complete unit with each bulkhead forming a torsion box which distributes the wing load evenly over the entire wing area. Two 24-gal. fuel tanks are formed as an integral part of the wing by sealing off the forward section of each wing at the root area.

Three-position, manually-operated flaps span 70% of the trailing edge of the wing and have a total area of 17.2 sq. ft. Ailerons have a total area of 11.2 sq. ft., with all gaps between controls and attaching members sealed to prevent disturbance of the air flow. Positive, direct connection to control surfaces is provided by linkage push-pull torque tubes which eliminate the slack normally associated with cable systems.

Fuel is fed from one tank at a time, via aluminum fuel lines, through the selector valve on the floor beneath the pilot's seat, to the sediment bowl where it then passes through the fire wall to an engine-driven pump and the carburetor. An auxiliary electric fuel pump is also provided for take-offs, landings and emergencies.

The manually operated landing gear has bungee-type springs in the fuselage and gear-assist springs in the wings to assist in the retraction and lowering of the gear. New over-center-lock springs positively force the down-locking mechanism into place when the gear is lowered. The attaching points of the main gear are in metal bushing attached to the spar in such a manner that the gear will tear loose if shock is severe, rather than permit it to puncture the fuel tank. The steerable nose wheel is attached to the cabin's tubular-steel frame and not to the engine mount.



MARK 21 fuselage consists of welded chrome-molybdenum steel tube frame with aluminum skin. Fuselage tail cone section has been redesigned for added strength.

1961 Mooney Mark 21

FAA Type Certificate 2A3

Maximum gross weight	2,450 lb.
Empty weight	1,490 lb.
Maximum baggage capacity	120 lb.
Wing loading	14.7 psf.
Power loading	13.6 lb./hp.
Maximum air speed (gross weight)	190 mph.
Maximum cruise speed (75% power @ 2,400 rpm. @ 7,500 ft.)	180 mph.
Optimum cruise speed (67% power @ 2,300 rpm. @ 7,500 ft.)	172 mph.
Economy cruise speed (55% power @ 2,200 rpm. @ 10,000 ft.)	164 mph.
Stall speed (power off, landing gear and flaps down)	57 mph.
Rate of climb (sea level)	1,150 fpm.
Best normal climb speed (indicated)	105 mph.
Service ceiling	20,000 ft.
Normal range (at 9,000 ft., no reserve)	915 mi.

The magnesium-cast main wheels have a 9-ft. tread and are equipped with six-ply tires and hydraulic (petroleum base fluid) double-action, air-cooled, disk type brake shoes.

The 12-volt electrical system uses a Delco-Remy starter, 50-amp. Delco-Remy generator, Rebat 33-amp. battery and the new Bendix S-200 "shower of sparks" type magneto system. The engine is provided with a separate electrical system and will continue to run even though the master switch has been turned off or should the accessory electrical system fail. Should it be necessary to start the engine manually, a switch to disconnect the starter is provided on the upper section of the fire wall next to the starter vibrator.

Entrance to the Mark 21 cabin is via a retractable step and right-wing walk-up. The step retracts completely into the wing-root fairing, eliminating drag. Step retraction is independent of the landing gear and is accomplished via two and a half turns of a crank located on the cabin wall opposite the pilot's left knee. Failure to retract the step will result in an airspeed penalty of 5 mph.

Compact Cabin

The compactness and 'within-reach' features of the cabin are evident as the starting procedures are initiated. After adjusting the pilot's seat for comfort it was not necessary to lean forward in the seat to turn-on switches or activate levers.

Instrument grouping on the shock-mounted panel follows the accepted standard of placing flight instruments on the left with radio equipment on the center panel and engine instruments on the right, with landing gear, wing flap and cowl flap controls grouped under the center panel.

The Lycoming engine was started and the aircraft taxied out for engine run-up. Wide visibility was provided by the large window area and tricycle attitude of the plane while taxiing, with responsive control of the aircraft provided by the steerable nose wheel and hydraulic toe brakes.

Completing run-up procedures, clearance was obtained from Teterboro Airport, N. J., with ceiling unlimited, winds calm, temperature 50 deg. F. and altimeter setting 30.40.

Take-off was normal; pushing the throttle to full power at 2,700 rpm., the aircraft accelerated to 65 mph. before back pressure was applied to lift the nose wheel off the ground. The Mark 21 broke clear of the ground at an indicated air speed of 70 mph.; back pressure was released on the control so as to pick up climb-out speed of 110 mph.

Gear is retracted by sliding the gear handle from the 'down-lock' position under the center panel and by pulling the gear handle down to the floor between the pilots' seats, sliding the handle into the 'up-lock' position. Inasmuch as the gear is raised manually, a slight resistance is met when moving the gear handle through the arc from the panel to the floor as the spring action is overcome.

After retracting the gear, power for climb-out was set at 25 in. of manifold pressure and 2,500 rpm., which enabled the aircraft to climb to an altitude of 3,000 ft. at a rate-of-climb of 1,100 fpm. at a steady 110 mph.

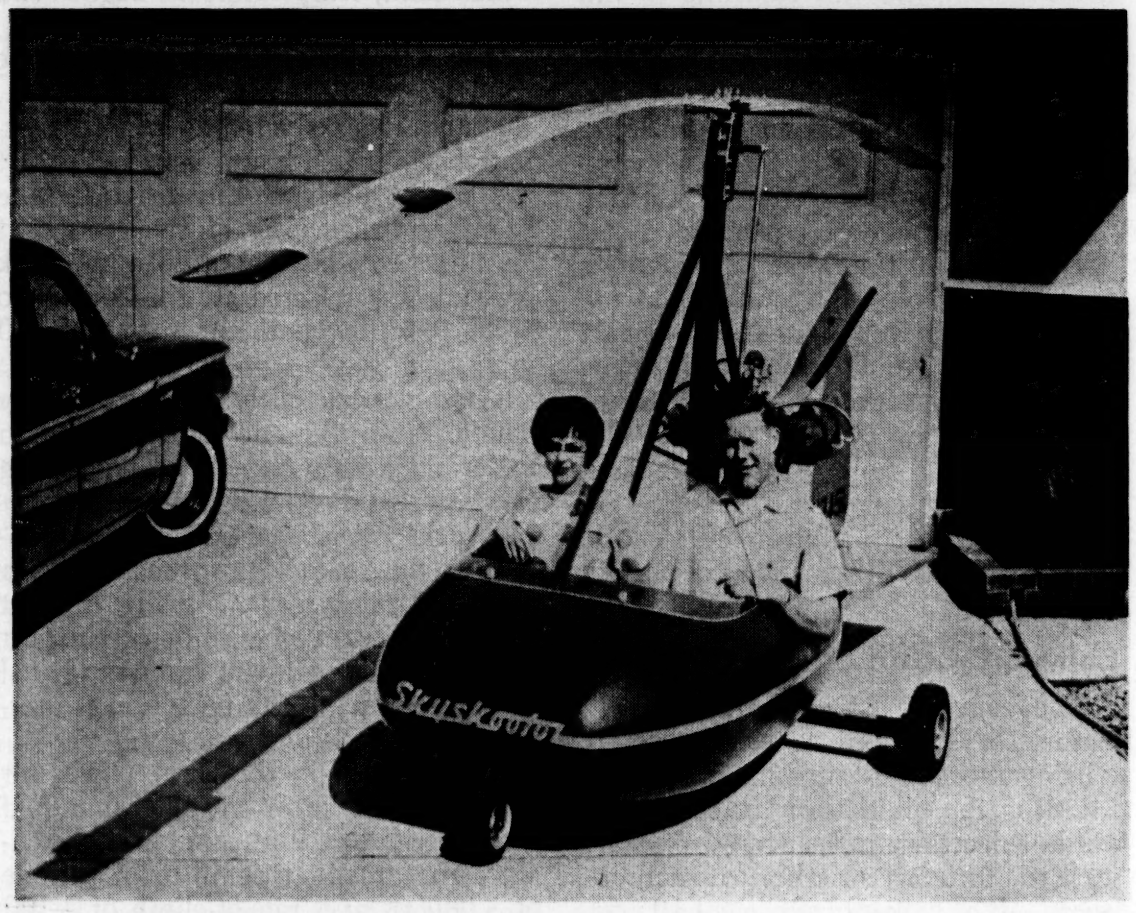
At 3,000 ft. the Mark 21 was trimmed and powered for cruise. At 22.5 in. manifold pressure and 2,300 rpm. (71% power) the aircraft indi-

cated 155 mph., which at 35 deg. F. calibrates to 165 mph. true air speed, with fuel consumption at 9.8 gal./hr.

Stability of the aircraft, in all attitudes, was excellent. In slow flight, (10 in. manifold pressure—70 mph.) aileron response was positive with no sluggishness evidenced. Stalling the Mooney Mark 21 straight and level, it stopped flying at 62 mph.; with gear and flaps down, it stalled at 57 mph., and in a steep turn the Mark 21 stalled at 60 mph. In each configuration the aircraft had no tendency to drop a wing. The buffeting and porpoising attributed to the Mark 20 when it stalled was definitely missing in the Mark 21.

The landing pattern is flown at 100 mph. downwind with one-third flaps; base leg at 90 mph. with two-thirds flaps and 80 mph. and full flaps over the fence. On the first landing the aircraft came in fast and floated on flare-out but good aileron and rudder response right through the stall-speed range set the aircraft down without difficulty.

Next time around the airspeed on final was kept close to that recommended and with the addition of back pressure as power was reduced over the runway the Mark 21 settled nicely and rolled to a stop within a few hundred feet.



Autogiro Skyskooter Cruises at 65 mph.

New Skyskooter autogiro built by Saalfeld Aircraft Co., San Diego, Calif., weighs 275 lb. and has an over-all length of 10 ft. With a ceiling of 12,000 ft. its top speed is 85 mph., cruising speed 65 mph. and slow flight 25 mph. It features autorotation with or without power. Range is 250 mi. Skyskooter can be assembled from factory kits and plans.

PRIVATE LINES

Forty United Kingdom business and industrial firms have joined the newly-formed Business Aircraft Users' Assn. (AW May 15, p. 123) which will promote business flying in and from the U. K. Founder firms are: Sir Robert McAlpine & Sons; McVitie & Price; United Steel; British Motor Corp.; Pasolds; Ind Coope; David Brown Industries; Rolls-Royce; Rootes Group; Dunlop Rubber; Leyland Motors; Shell Mex and BP; Esso Petroleum; Vigors Aviation; Steel Co. of Wales; Unilever and Whitbread & Co. Association headquarters are at Londonderry House, Park Lane, London W.1.

First European delivery of a Piper Cherokee will be to Jonas Aircraft, Paris, Piper's European representative. Aircraft was scheduled to be displayed at Paris Air Show before delivery. First U. S. delivery will be to Wes-Tex Aircraft Sales, Lubbock, Tex.

Timmins Aviation, Ltd., operators of Texaco Sky Service Centres, presently operating air terminals for privately owned aircraft in Montreal and Toronto, will open facilities in other major cities from coast to coast in Canada with an Avis-Rent-A-Car System tie-in.

Agusta-Bell 204B, powered by 1,050-shp. de Havilland Gnome turbine (General Electric T58 built under license), has started its flight test program near Milan, Italy. Powerplant installation, planned at making 204B attractive to European market because of close source of supply, is main variation between Agusta 204B and Lycoming T53-powered Bell-built 204B (HU-1B).

Pacific Airmotive Corp.'s 9,800-lb. gross weight modification to the Twin-Beech has been certificated by the Federal Aviation Agency for installation on aircraft with either Hamilton Standard or Hartzell propellers and a standard windshield. Modification includes powerplant modernization, modified horizontal stabilizer angle of incidence, wrap-around wheel well doors, improved wingtips, and 40,000 Btu. heater installation. Resultant performance improvements include METO power increase to 450 hp., gear lowering speed of 160 mph., and 21 mph. increased cruise speed at 270 hp. Installation price is $12,995. Kit price is $8,950.

Hawker Siddeley Reports Earnings

London — Hawker Siddeley Group profit for the 17-month period since absorption of A. V. Roe was $21.7 million, compared with $17.5 million for the preceding 12-month period. The 17-month figure was used because it includes 15 months' earnings of de Havilland and Folland, and nine months for Blackburn.

Hawker Siddeley has written off $43.5 million on costs of aircraft and engine development over the 17-month period ending Dec. 31.

The writeoff compares with $8.4 million written off for that purpose in the preceding year and covers expenditures on Armstrong Whitworth Argosy and Avro 748 turboprop transports, the de Havilland Trident three-jet transport, de Havilland (Canada) Caribou and the de Havilland Gnome turbojet engine.

Total sales for the Group, which includes wide industrial interests, was a record $1.3 billion, an increase of $7.2 million. In the period reviewed, the group acquired de Havilland, Folland and Blackburn in the aviation field.

The directors said the "substantial writeoff" against aircraft development demonstrates "the necessity for large private-venture expenditures to keep Hawker Siddeley in the forefront of the aviation industry."

The directors also reported that A. V. Roe of Canada showed a loss of $1.6 million in the 17-month period but added "some slight signs of recovery are now becoming apparent."

Astek to Produce Jet Transport Instruments

New York—Astek Instrument Corp. has been formed for the design and production of integrated flight instrument systems for commercial jet transport aircraft. The new company, located in Armonk, N. Y., says it will emphasize commercial sales. It also will build military aircraft and space vehicle flight data systems.

Everett H. Schroeder, former sales director of Kollsman Instrument Corp., will serve as president of Astek. Jack Andresen, former Kollsman chief engineer, is vice-president of the new company.

Astek (for air/space technology) will build altimeters, airspeed indicators, Machmeters and airspeed and altitude controllers as well as integrated systems. The company says that its lack of investment in production tooling is advantageous in that it will enable Astek to utilize the most advanced techniques in producing its instrument designs. Design goals for the company are development of pressure-actuated instruments with improved precision, reliability and presentation. Astek says that to meet varied airline requirements, it will design both three-pointer and drum-pointer presentation altimeters.

New Offerings

Missile Sites, Inc., Wheaton, Md. (formerly known as Samuel N. Zarpas, Inc., a Delaware company); general policy of the company is to do business as a prime contractor with governmental agencies, including active solicitation of bids on prime contracts for Nike, Bomarc, communication and radar sites and other specialized facilities involved in these programs, and it has undertaken a number of projects with Fullerton Construction Co. as joint venturers. Offering is 291,000 shares of common stock for public sale at $5 per share. Proceeds will be added to working capital, thus enabling the company to undertake larger government contracts which are involved in new missile site programs; a portion of the proceeds may be used for the purchase of equipment, inventory or other business property.

San Francisco & Oakland Helicopter Airlines, Inc., San Francisco, Calif.; organized under California law in January, 1961, the company proposes to engage in the business of furnishing scheduled air transportation service by helicopter in the San Francisco Bay area. Initially it expects to furnish such service by means of two 10-passenger S-62 Sikorsky helicopters; the company has entered into a lease-purchase contract with Sikorsky Aircraft Division of United Aircraft Corp. for the acquisition of the two S-62 helicopters with which to commence operations.

Offering is 85,000 shares of Class A stock ($10 par cumulative preferred dividends, non voting) and 85,000 shares of common stock, for public sale in units consisting of one share of Class A and one share of common; offering price and underwriting terms to be supplied by amendment. Of the proceeds, $63,500 will be used for one spare General Electric CT-58 turbine engine; $22,500 as further deposit on each of the two helicopters (a $10,000 deposit was paid at the time the Sikorsky contract was executed); monthly lease payments of $5,000 per helicopter; $30,000 for additional spare parts and maintenance; the balance for starting-up expense and necessary working capital. Any remaining proceeds may be used by the company to exercise its option to purchase the leased helicopters on or after May 31, 1962, at the price of $228,458 each, less the deposit of $27,500 each.

Aerojet-General Corp., Azusa, Calif., engaged in research, development and manufacture of rocket engines for military and space exploration purposes; it also conducts chemical research and development programs relating to new propellants, and designs, develops and produces detection and guidance equipment based upon infrared radiation, an advanced torpedo system for the Navy and other underwater and anti-submarine warfare devices, and other ordnance products. The company and a subsidiary are developing a portable gas-cooled nuclear power system for the Atomic Energy Commission and small nuclear plants for use in space vehicles for the Air Force and the National Aeronautics and Space Administration; another subsidiary is active in communications and data transmission, advanced telemetry sciences, guidance and control and other equipment; a division engages in studies and production of package sorting and handling equipment; and the company operates a facilities engineering service for the design and construction of missile test facilities.

Offering is $15,000,000 of 5¼% sinking fund debentures due 1981, for public sale; interest rate, public offering price and underwriting terms to be supplied by amendment. Of the proceeds, $6,000,000 will be used to repay short-term indebtedness owed to the General Tire and Rubber Co, the parent company; the balance will be applied to the repayment of short-term bank loans.

Such indebtedness and bank loans were incurred to finance capital additions and increased working capital requirements.

Rocket Jet Engineering Corp., Glendale, Calif., primarily engaged in the design, development and manufacture of escape and survival equipment used in the life support system installed in military aircraft. Offering is 110,000 outstanding shares of common stock, for public sale on an all or none basis; public offering price and underwriting terms to be supplied by amendment. Pursuant to a recapitalization scheduled for April 1961, its 825 common shares then outstanding will be exchanged for 539,000 common shares (with a book value of about 79¢ per share).

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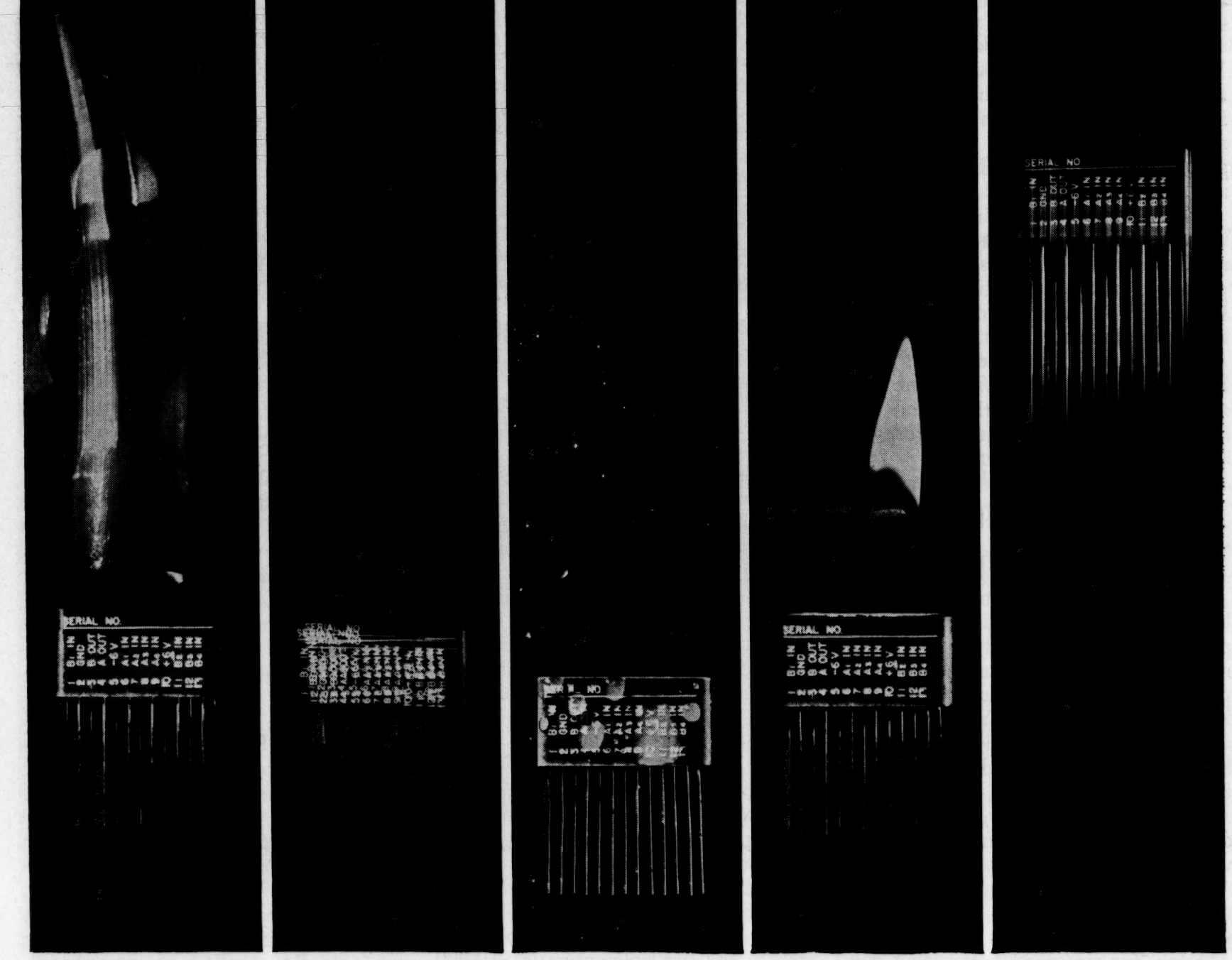

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CAB Accident Investigation Report—Part II

Whirl Mode Is Linked to Electra Accident

(This is the concluding half of a Civil Aeronautics Board report on the crash of a Braniff Electra at Buffalo, Tex., Sept. 29, 1959. The first part of the report appeared in AVIATION WEEK, *May 29, p. 91.)*

N 9705C was a new aircraft. Its final assembly was started in April, 1959, and the first of its three production test flights was on September 4, 1959, 25 days prior to the accident.

Braniff Airways accepted delivery of the aircraft at the factory, Burbank, California, on September 18, 1959. Acceptance had been preceded by a total of three production test flights and one acceptance flight.

The four propellers and three engines in Nos. 2, 3 and 4 positions had been installed new (zero time). The No. 1 engine had accumulated 26 hours and 25 minutes of operation at the time of installation.

Upon arrival of N 9705C at the Braniff Airways Base at Dallas, Texas, an acceptance inspection was conducted incorporating the operations of Nos. 1, 2, 3 and 4 maintenance and inspection procedures. After the acceptance inspection N 9705C operated approximately 122 hours in scheduled and training flight (total time was 132 hours and 33 minutes); therefore the first or No. 1 inspection due at 205 hours had not been performed. As a result only preflight service checks and non-routine items were accomplished during the ten days of operation.

The only areas of chronic difficulties with N 9705C appeared to have been with the radio, navigational equipment and the generator malfunctioning during the last few flights. This latter generator malfunctioning was reported to have been corrected.

Several incidents to other Electras were investigated. These consisted of: (a) possibility of excessive fuel tank pressures; (b) review of a report concerning a landing gear tire failure caused by excessive brake temperatures that resulted in an explosion of the tire approximately 30 minutes after takeoff. This caused excessive damage to the nacelle structures; (c) loss of an intermediate tail pipe cover in flight; (d) review of starter bottle compressor difficulties (this last item has been a chronic difficulty fleetwise and the No. 2 compressor in the No. 3 nacelle had been de-activated in N 9705C at the Dallas Terminal some two hours prior to the final flight); and (e) an over-all general monitoring of L-188 difficulties for any correlation with the findings to date.

All areas investigated resulted in negative findings. All squawk items during factory flight tests were signed off as corrected. All maintenance items on this aircraft, including all checks and inspections as well as correction of all items pertaining to airworthiness appearing in the flight log (squawks) had, according to company records, been complied with by Braniff personnel in full accordance with prescribed and approved methods.

Braniff Airways maintains a special technical group to monitor the Lockheed L-188 operation. A folder is kept for each aircraft as a means for keeping individual aircraft chronological records. No significant entries were found.

On September 22, one week before the disaster, the aircraft was used on a routine training flight. Recovery from a planned stall was made incorrectly and a secondary stall developed, attended by buffeting more severe than normally allowed. The Braniff captain in command expressed the opinion that structural integrity was not impaired and that no inspection was needed.

Crew History

Captain Wilson Elza Stone completed Lockheed Electra L-188 ground school training on April 10, 1959. The course consisted of 120 hours of instruction on aircraft systems, performance, and flight planning. His average grade for the course was 96. In addition, an L-188 refresher course and cockpit check was completed by Captain Stone on May 17, 1959, and involved a total of 12 hours attendance.

Captain Stone's L-188 flight training commenced May 18, 1959, and was completed May 27, 1959. This training covered general preflight duties; air work, en route and emergency procedures, included simulated engine failure and engine fire at altitude; simulated emergency procedures, day and night takeoffs and landings; and instrument procedures. This type rating check was given by an FAA designated ATR examiner after 8 hours and 45 minutes of flight training. His flight proficiency was above average on this check. Captain Stone then flew for 12 hours and 34 minutes with company check pilots prior to being assigned to regular line operations. His total Electra time was 68 hours and 39 minutes.

First Officer Dan Hollowell completed Electra ground school training on July 3, 1959. He received an average grade of 95 for the 120-hour course. Flight training commenced July 10, 1959, and was completed July 31, 1959. First Officer Hollowell received a total of 4:30 hours of flight time in the Electra, and 8:45 hours of observation time. A review of the records indicated that he was current in all requirements. His total Electra time was 95 hours and 30 minutes.

Second Officer Roland Longhill completed the 120-hour Electra ground school course on March 20, 1959. His final examination grade was 93. He was qualified for duty as a flight engineer on Electra equipment on August 12, 1959, after completing 10:40 hours of instruction. His total Electra time was 83 hours and three minutes.

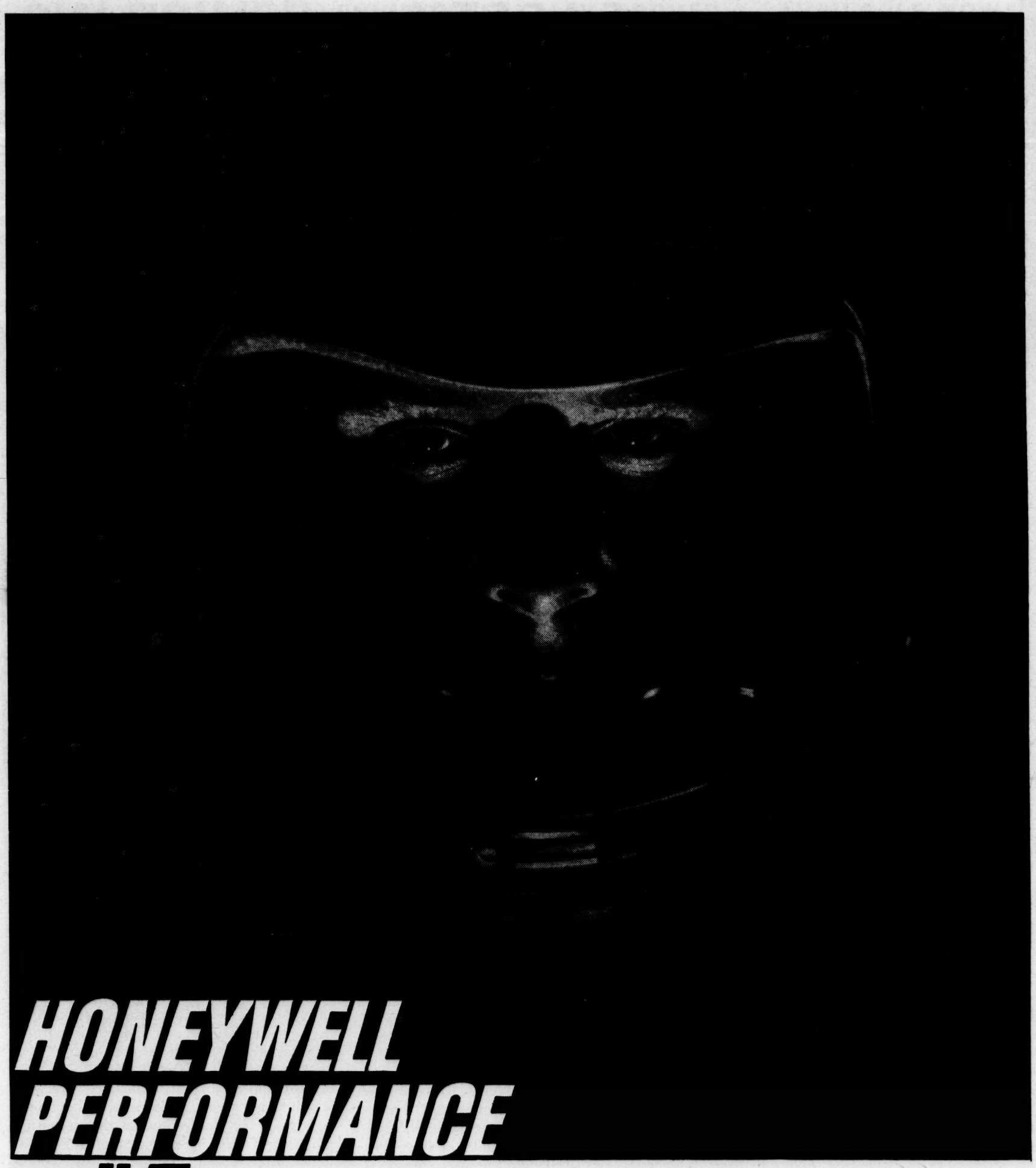
Traumatic injuries to occupants, some of whom had fallen free of the aircraft, were severe and extensive, with much mutilation.

Examination of tissue for carbon monoxide level was made from nine bodies, one of which was that of First Officer Hollowell. It and seven others showed carboxyhemoglobin saturation of the blood and tissue at less than 10%. Medical opinion is that this is not an incapacitating quantity. One of the nine showed a 13% concentration, indicating possible inhalation of smoke laden air prior to death.

The investigation of this accident has produced such a voluminous quantity of data that this report will be confined to the discussion and analysis of only those data considered to be apropos to the consideration of probable cause. Several incidents and accidents involving Electras have occurred during the course of this investigation, all of which have also been investigated. None of these is considered to have any association with this accident except the accident to a sister aircraft at Cannelton, Indiana, on March 17, 1960. The investigation results of that accident and their relevance to the solution of this case are discussed below.

Much of the information appearing under "Investigation" is of a negative nature insofar as the probable cause of this accident is concerned. Such matters as atmospheric turbulence cannot be logically linked to this accident. The aircraft was operating in the clear at the time of the accident, well removed from the closest significant convective activity; and the necessary meteorological parameters for the formation of clear air turbulence were not present (i.e., vertical or horizontal wind shear, strong jet stream, sharp upper trough). The subject of pilot and flight engineer competence cannot be considered a factor, for all three were well qualified and experienced airmen despite having less than 100 hours in Electras. Also, the possibility of crew incapacitation, even in small degree, by any toxicity is without foundation and is not even suspected. The aircraft itself was virtually new and had not needed appreciable maintenance work; that which had been accomplished had been signed off in accordance with established practices. Collision or threatened collision with another aircraft or object has been ruled out and the flight was being navigated properly.

Laywitnesses are often in error, particularly in their attempts to recount time lapses, the exact sequence of events, or altitudes. It is difficult, even to a trained observer, to recall accurately the order of an unanticipated rapid succession of events. There is in this accident, however, one condition which fixes the sequence and establishes to some extent a time boundary between two important elements of observation: (1) the sound, variously described as "jet noise," "low flying aircraft," "unsynchronized motor," and (2) the observation of "a large orange ball of fire." Six witnesses were indoors when



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startled by a noise of sufficient intensity to get them to look or go outside.

Certainly, some of their observations cannot be reconciled such as the white light seen by one witness; nor do the various times between events check out with any high degree of accuracy. However, all of the witnesses who were indoors first heard a noise which was followed by a ball of fire.

Several witnesses gave reasonably good descriptions of objects silhouetted between them and the ball of fire. This information correlated well to fix the geographic position and an approximate altitude band for the fireball. When plotted, the altitudes of sighting varied from 17,000 feet to about 24,000 feet. While the variation here is wide, it does indicate that the fireball was at high altitude and probably no lower than the 15,000 feet reported on the radio by the crew.

Using a speed of sound of 1,088 feet per second, which is the standard-day average between sea level and 15,000 feet, it can be shown that from a simultaneous noise and light at 15,000 feet, an observer directly below would hear the sound about 14 seconds after seeing the light. An observer three miles away would not hear the sound for an additional six seconds. (Normal temperature variations and even strong winds will make only negligible differences in time.) The loud continuing noise, then, had to occur 14 or more seconds prior to the appearance of the fireball, plus the time interval between the witness observations of noise and light.

Analysis of the witness statements shows that the information provided by a majority of the witnesses is reasonably consistent. The average time for noise (at the source) to the appearance of the ball of fire was in the order of 33 seconds, with the largest variation from the average being about eight seconds.

The witnesses who saw the fireball from inception agree that there was no prolonged fire, but rather a small one which grew quickly into a large orange or red ball and then disappeared in a few seconds. Several witnesses observed that just prior to extinguishment, a smaller fire emerged from the large ball and fell to the northeast, dying out well before reaching ground level.

That the aircraft broke up violently is self-evident. That the breakup process was both quick and with little or no warning is also clear for two reasons. First, only one of the 37 aircraft's passenger seats recognizable as such was found with the safety belt fastened, and this probably means there was no time to order their fastening. Second, the final radio message preceded the breakup by an interval of something less than two minutes and that message gave no hint of trouble.

Failure Sequence

A definite sequence of failures and breakages appears discernible and will be mentioned because it may be considered as somewhat basic for this anlysis. Separation of the left wing and the No. 1 gear box propeller and QEC structure occurred at about the same time; it is impossible to say which went first. The horizontal stabilizer then broke up under the impact of parts coming from the wing; wing planking from the right wing tip came free; the No. 4 powerplant tore loose; and the right wing outboard of No. 4 separated. All of these events happened in a short period of time. Somewhat later, at much lower altitudes, the fuselage broke in two separate portions at a point about halfway back near fuselage station No. 570.

Under "Powerplants" mention was made of there being no evidence of overspeeding. However, in view of the tolerance of both the engine and propeller to overspeeding before any physical evidence develops, 20 percent and 53 percent, respectively, lack of this evidence does not permit concluding an overspeed of a lesser amount did not occur. However, it is difficult to project an overspeed as such into an accident of this kind. The following devices are incorporated in the engine propeller design to protect against overspeeding and/or high drag: (1) fuel control overspeed governor, (2) negative torque signal, (3) safety coupling, (4) hydraulic and mechanical low pitch stops, (5) beta followup, and (6) pitch lock. These features, some of which function entirely independently, provide multiple protection against powerplant induced drag of a degree which would present airplane control or structural loading problems.

Also, under "Powerplants" there is mention of possible emergency procedures having been used on No. 3 powerplant. However, the evidence indicating that emergency action may have been taken with respect to No. 3 powerplant is not supported by the physical condition of the engine and propeller. This powerplant was the last to separate from the airplane, possibly at contact with the ground. That the oil shutoff valve was only partially closed indicates the operation was prematurely terminated, most likely by a loss of electrical power. It appears that emergency action with respect to this engine was initiated just prior to or during breakup by either the crew or by actuation of the control due to disruption by the airplane breakup. Any significance of these valves with respect to the accident is not discernible.

In reference to the statement under "Powerplants" that the No. 1 propeller, engine gear case, torquemeter, air inlet case, and QEC structure separated and fell as a unit, the following should be noted. This separation occurred following failures in the QEC which permitted movement of the rear of the engine. Had the engine separation occurred first the repeated markings made on the adjacent shrouding by the clamp on the rear of the engine would not have occurred.

It is concluded that the normal support provided by the mounts at the reduction gear case was disrupted, thus permitting loads generated by the rotating propeller to be transmitted through the engine structure causing gyrations of the rear of the engine within the confines of the adjacent shrouding and ducting. Separation at the air inlet and compressor case junction occurred in an upward and slightly to the left direction with the forward portion also rotating clockwise about a center five to six inches outside the bolt circle positioned radially about the 11:00 o'clock position. This separation occurred by tension failures of the $\frac{1}{4}$—28 cap crews and pullout of the $\frac{5}{16}$—24 inserts.

A study of this separation failed to reveal any evidence of repetitive relative motion as separation occurred. The loading necessary

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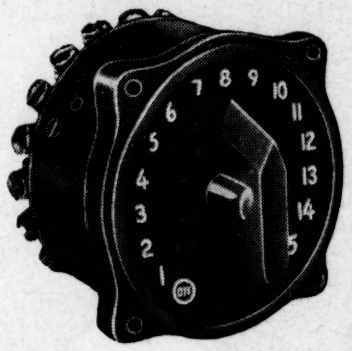

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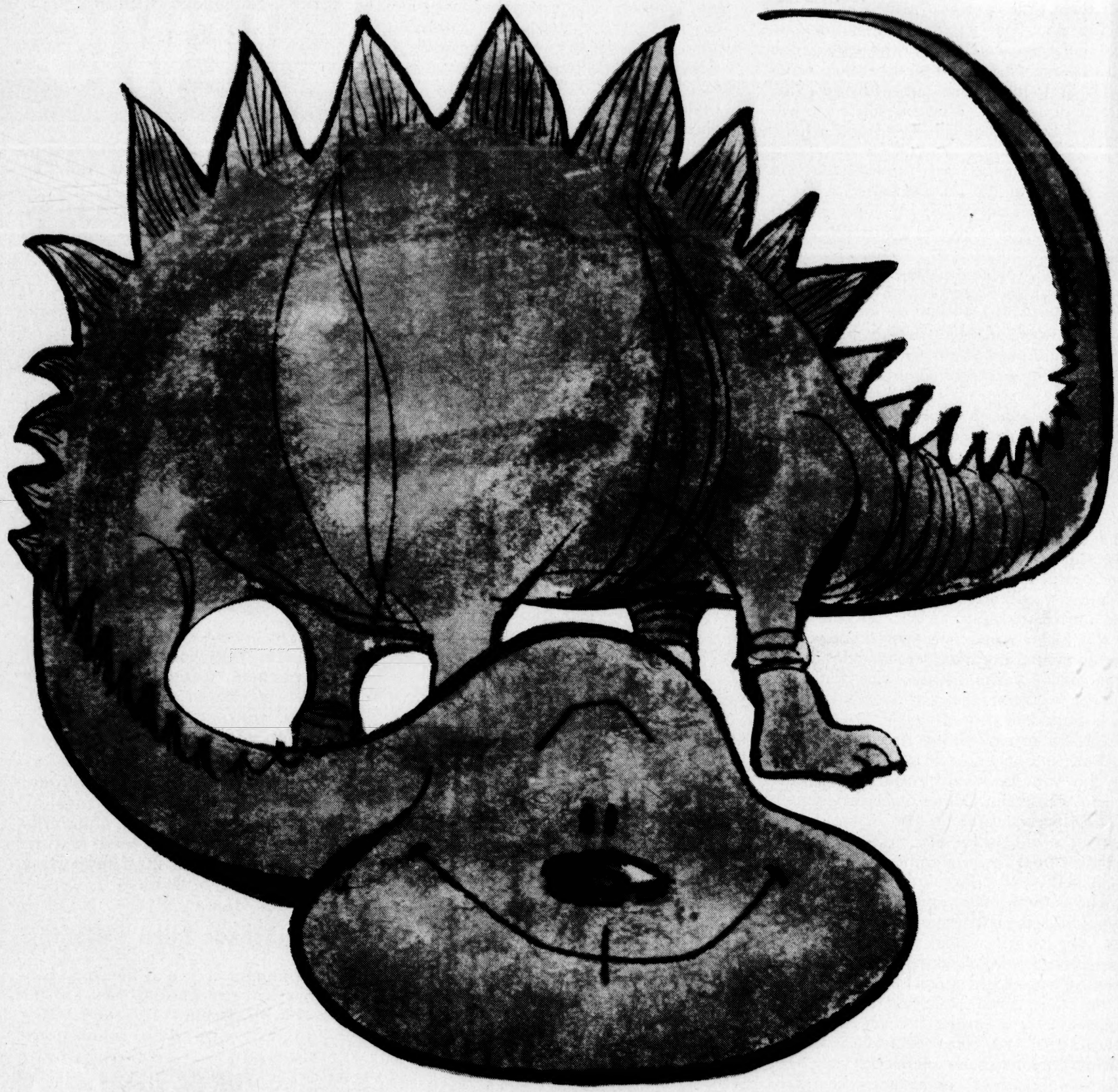

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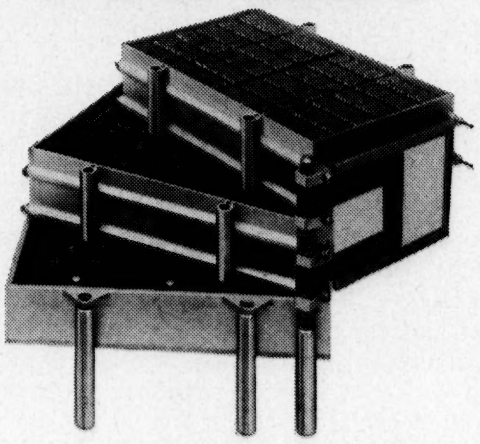

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to bring about this separation could have occurred only after the QEC structural integrity was disrupted, and propeller-generated loads that were intended to be absorbed by the Lord mounts which support the reduction gear assembly were instead transmitted rearward through the intact engine structure.

Interference of the first stage compressor blades with the air inlet housing occurred on the No. 1 engine of this aircraft and on the Nos. 1 and 4 engines of the Electra involved in the accident at Cannelton, Indiana. There was separation in flight of some portion of these three engines. These similar circumstances cannot be accepted as coincidental since like circumstances prevailed in each case. It is believed this rotational interference was caused by air inlet case deflection due to abnormal loads being applied through the engine torquemeter housing and structs. Furthermore, these abnormal loads followed disruption of the engine supporting structure such that loads normally taken out by the forward QEC Lord mounts and structure were, instead, imposed on the engine structure. It follows that the basic engine structure forward of the compressor must have been intact in order to transmit propeller generated case distorting loads. The design strength of the basic engine structure is materially greater than that required by the Civil Air Regulations for its supporting structure. This suggests that structural damage due to overloads by whatever means would be confined initially to the supporting structure. Thus, the previous conclusion that engine supporting structure disruption preceded the engine structure damage is further substantiated.

No. 1 propeller blade angle and markings on the load side of the compressor extension and stub shafts' splines indicate power was being produced when the separation occurred.

As stated under "Investigation" no indication of operational distress was found through examination of the hydraulic and electrical system components. Examination of the radio transmitters and receivers revealed no sign of malfunctioning.

Damage to the control surface boosters precluded establishment of booster selection, i.e.: "On" or "Off" or whether the autopilot had been in operation prior to the breakup of the aircraft. Although the broken lead at the elevator load sensor probably failed as the result of a few (possibly three or four) cycles of reversed bending, it is not known whether the failure occurred prior to or as a result of the accident. It may well have broken during the violent shaking which could have preceded the inflight breakup. If the failure existed in flight and the aircraft were being flown on autopilot, the automatic elevator trim feature would be inoperative and any change in longitudinal trim would be accommodated by the autopilot. With the autopilot holding against an out-of-trim condition, up to the limit of its authority, sudden release of the autopilot would result in a relatively mild pitchup or pitchdown, depending upon the direction of trim imbalance. This would not create a hazard or place the aircraft in an attitude from which recovery would be difficult.

The extremely brittle ash residue of the left air compressor of the air start system

PROBLEMATICAL RECREATIONS 69

A bricklayer has 8 bricks. Seven of the bricks weigh the same amount and 1 is a little heavier than the others. If the man has a balance scale how can he find the heaviest brick in only 2 weighings?

—Contributed

Latest Developments on the Learning Process Front: Litton Industries and Prentice-Hall, textbook publishers from way back, will be in the teaching machines business. Litton will design and build the machines for use with programmed materials developed by Prentice-Hall. Should prove educational.

ANSWER TO LAST WEEK'S PROBLEM: Yes. The first player should appropriate the only unique point by placing the first cigar vertically on its flat end over the center of the table. From then on he can counter each of his opponent's moves by "reflecting" them through the center of the table.

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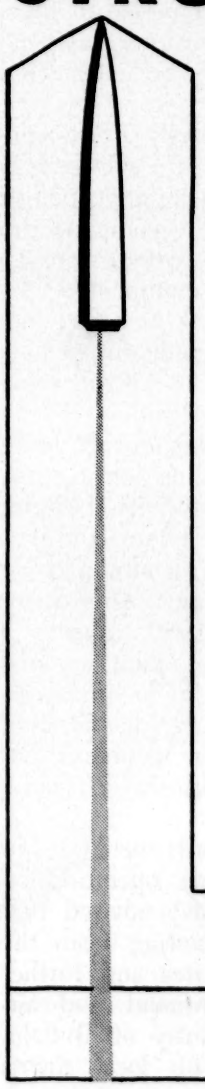

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flaked away readily when handled, indicating that the compressor had burned where found on the ground at the left wing impact site. Examination of the engine fire extinguishing system showed that the selector valves were in their normal positions and that none of the fire bottles had been discharged by crew action.

The pertinent observations of the physical evidence can be summarized as follows:

Inflight fire was confined to the extreme inboard portion of the left wing, causing heat damage to the left windows rear of the wing trailing edge and sooting of the left rear fuselage.

The No. 2 fuel tank showed no evidence of internal pressure or explosion; planking fragments were burned and sooted in a random pattern.

The left inboard leading edge, the lower planking and the rear spar showed that the left wing failed at the inboard one-third of the No. 2 tank in upward bending and noseup torsion. The relatively small fragments of the upper planking indicated a strong probability of failure resulting from a high positive load.

The wing station No. 83 closing rib of the left leading edge showed metal-to-metal scratches. Microscopic examination disclosed three to four changes of direction in these predominantly vertical marks.

The fracture faces of lower wing plank No. 3 at wing station No. 65, left, showed evidence of having recontacted each other after the fracture occurred. Microscopic examination revealed at least three cycles of recontact.

The forward attach point of the No. 1 QEC upper outboard longeron showed heavy compression loading prior to failure and further disclosed multiple directions of local bending in the several longeron members.

The forward attach area of the No. 1 QEC upper inboard longeron revealed a tension failure followed by a recontact of the fracture faces in a would-be compression load.

The electrical connectors and their wiring at the No. 1 nacelle firewall were failed in multiple directions of bending.

At the No. 1 firewall, the fuel line was bent up/inboard and down/outboard prior to ultimate failure which was up/outboard.

Found in the No. 1 nacelle shroud were indentations which were made by the antiswirl assembly clamp bosses. There were also multiple clamp marks around the shroud but less pronounced than those at the clamp splitline.

Both No. 1 gear box Lord mounts showed evidences of repeated yaw loads and some indication of rear load. The rear mount disclosed excessive relative motion of the mount with respect to the nacelle structure.

The No. 1 engine's first stage compressor blades rubbed the inside of the air inlet housing.

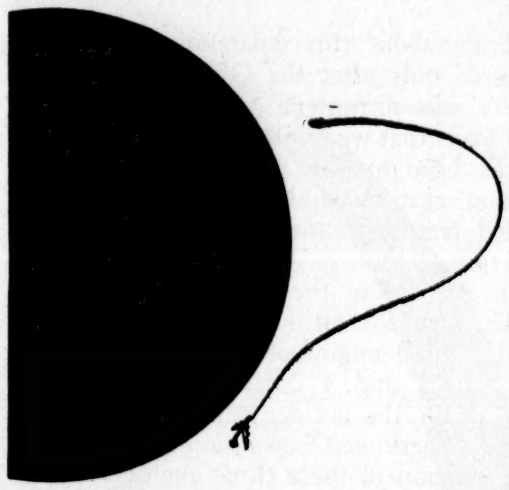
Examination of the structure for fatigue produced completely negative results.

In reference to the localization of the left inboard wing fire, as mentioned, it seems proper to present the following: At no point can there be found a continuous fire or heat pattern across the rear portion of the wing, particularly along the spar, the back side of which is white, and the upper trailing edge surface, the under side of which is white. This material was clean. Two of the flap beams, flap station No. 174 and flap station No. 106, showed some sooting; however, the soot marks are not continuous across break lines. The inboard flap beam at wing station No. 72 was completely clean. This beam went into the main wreckage area with the center section. The flaps themselves had fire patterns on them; however, at any point where there was a fire pattern it could be shown that it did not exist prior to the breakup of the flap and most of this fire occurred in the area where the flap was torn through as a result of wing failure. Inboard of the station No. 72 flap beam there was evidence of inflight fire, and such would be expected since there was a ball of fire passing through this area at the time of wing failure.

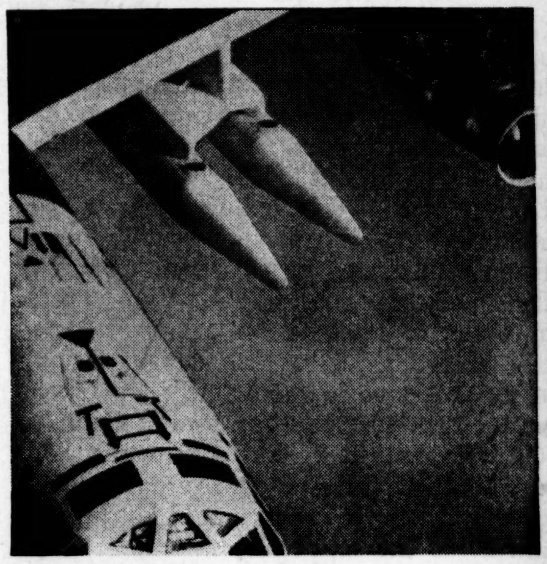
The only point at which fire or heat can get into the fillet area on the rear portion of the wing is through a small opening under the fillet and above the junction point of the upper cap of the rear spar to the fuselage. This area was completely clean and showed no evidence of soot, fire, or heat. This area, incidentally, is white and would show soot very readily. The only other way to get heat into the fillet area from outboard would be through the leading edge and through a similar opening from the leading edge into the fillet area; however, this did not get sooted in anyway. It was noted during the mockup period that the trailing portion of the wing fillet makes a scoop or funnel capable of holding several gallons of kerosene, and ahead of this area there is a place where additional fuel could be trapped for a short period of time. This could contribute to a more prolonged fire than might normally be considered possible.

Any comprehensive analysis must consider, along with the positive evidence in the wreckage, the following negative points:

- **In the 07 radio call** to the company the only maintenance items reported were an inoperative No. 3 sump pump and the bonding of a terminal strip. This was only two minutes prior to the accident.
- **There was no turbulence** along the route of this flight at operating altitudes.
- **There was no record** of this aircraft being subjected to a hard landing or to any appreciable turbulence during its 100-plus hours since manufacture. There could be found only one incident of any possible maltreatment of the airframe. This occurred on September 22, 1959, during a training flight wherein the pilot entered a secondary stall following an improperly executed stall recovery. Any likelihood of damage resulting from this maneuver has been evaluated and dismissed under "Investigation."
- **According to ARTC records** there was no conflicting traffic of aircraft operating on flight plan. The U.S. Navy advised that there were no aircraft operating from the only Navy facility in the area and further that no other Naval command had aircraft operating in the vicintiy of Buffalo. The Air Force reported no local flights



SKYBOLT



This new USAF weapon now under development will combine the range and mobility of the jet bomber with the speed and the difficult-to-detect capabilities of the ballistic missile. Yet Skybolt's warhead-carrying re-entry vehicle must operate with the same reliability and accuracy of ground-launched re-entry vehicles.

Environmental conditions—The re-entry vehicle must withstand hour after hour of vibration and noise fatigue aboard its bomber "launching pad"—the USAF B-52 and the RAF Vulcan bomber. Its heat protection system must endure repeated thermal cycling from ground take-off temperature to −65° F at cruising altitudes. If launched, it could be exposed to re-entry temperatures of 7500° F.

Extended Life—Skybolt's re-entry vehicle must have a useful life of several years, through repeated storage, thermal cycling, and return to storage—all with a minimum amount of maintenance.

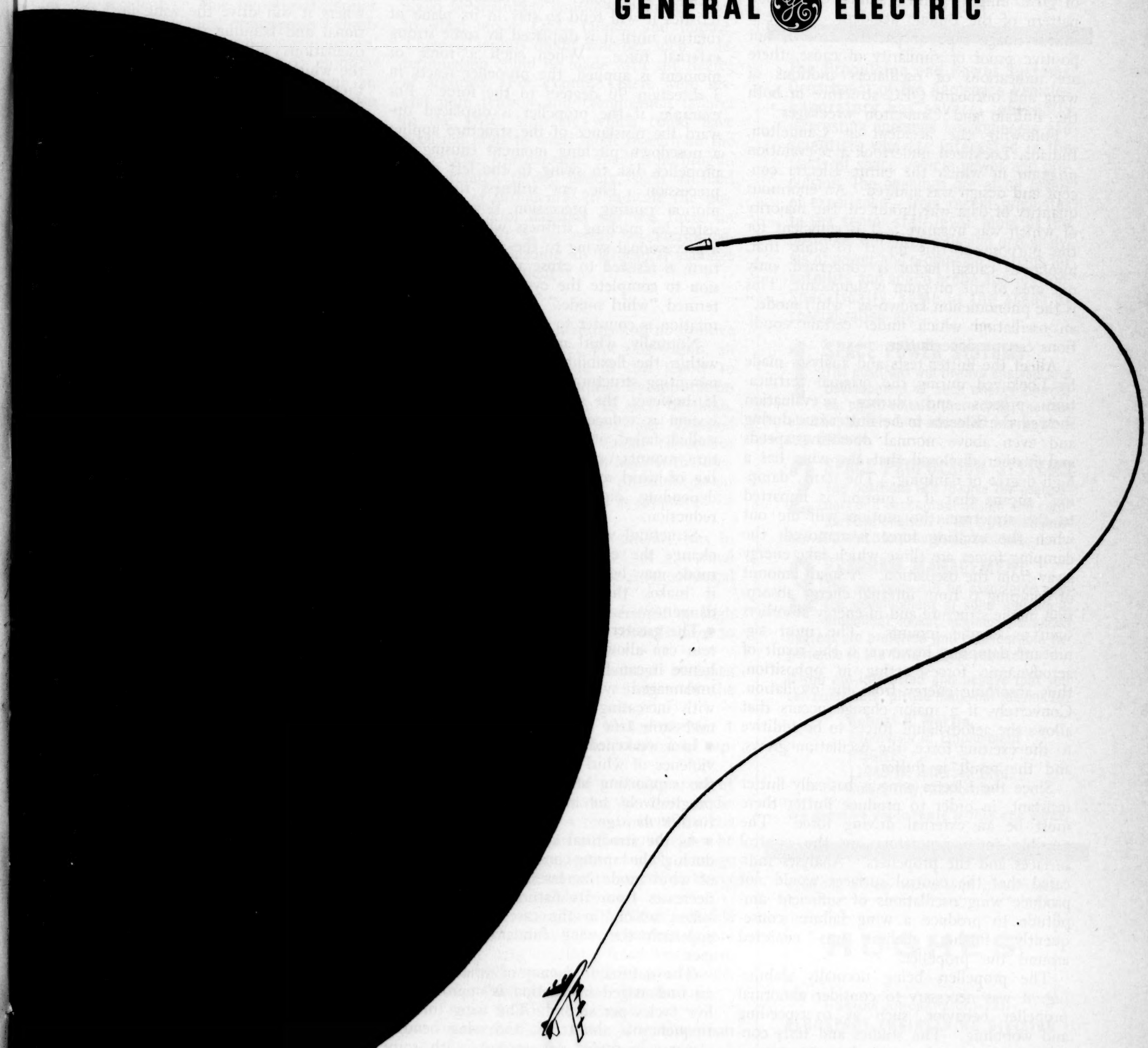
The Skybolt missile system is being developed from known and proven engineering principles, resulting in rapid program advancement at great saving to the American taxpayer. The Missile and Space Vehicle Department of General Electric's Defense Electronics Division is developing Skybolt's re-entry vehicle. 160-05

GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT, PHILADELPHIA, PA.

SKYBOLT is being developed to add a new dimension to America's growing missile might. Launched from an airborne B-52, it is being designed to arc through space toward targets more than 1000 miles away. The re-entry vehicles for this advanced USAF missile are being developed by General Electric's Missile and Space Vehicle Department under contract to Douglas Aircraft Company, prime contractor for Skybolt.

GENERAL ELECTRIC



from Barksdale Air Force Base between the hours of 2200 and 2400. Connally Air Force Base had aircraft in the area, but all had landed prior to the time of the accident. Carswell Air Force Base had two KC-135's on IFR round robins at accident time. (If these two had been in the Buffalo area IFR, ARTC should have had a record of this.)

• **In all of the examination,** testing, and analysis of the flight control systems, boost, and autopilot, no phenomenon could be produced which would produce or lead to a structural failure. (There was further work done in this area after the Cannelton accident.)

There is one other very important consideration. This is the Cannelton, Indiana, accident of a similar Electra, which also experienced a wing failure (right) and loss of QEC units to form a similar destruction pattern of the Buffalo accident. While a mirror image type of pattern itself is not positive proof of similarity of cause, there are indications of oscillatory motions of wing and outboard QEC structure in both the Buffalo and Cannelton wreckages.

Following the accident at Cannelton, Indiana, Lockheed undertook a re-evalution program in which the entire Electra concept and design was audited. An enormous quantity of data was produced, the majority of which was negative. It is sufficient for the purpose of this report to state that, insofar as causal factor is concerned, only one area of the program is significant. This is the phenomenon known as "whirl mode," an oscillation which under certain conditions can produce flutter.

All of the flutter tests and analyses made by Lockheed during the original certification process and during re-evaluation showed the Electra to be flutter-free during and even above normal operating speeds and further disclosed that the wing has a high degree of damping. The term "damping" means that if a motion is imparted to the structure, the motion will die out when the exciting force is removed; the damping forces are those which take energy away from the oscillation. A small amount of damping is from internal energy absorption in the structure and in energy absorbers such as engine mounts. The most significant damping, however, is the result of aerodynamic forces acting in opposition, thus absorbing energy from the oscillation. Conversely, if a major change occurs that allows the aerodynamic forces to be additive to the exciting force, the oscillation grows, and the result is flutter.

Since the Electra wing is basically flutter resistant, in order to produce flutter there must be an external driving force. The possible force generators are the control surfaces and the propellers. Analyses indicated that the control surfaces would not produce wing oscillations of sufficient amplitude to produce a wing failure; consequently, further analysis was centered around the propeller.

The propellers being normally stabilizing, it was necessary to consider abnormal propeller behavior, such as overspeeding and wobbling. The studies and tests conducted during the re-evalution program proved that a wobbling outboard propeller caused by weakened nacelle and/or engine structure can induce wing oscillations.

First Boeing C-135 Rolls Out

First of 30 C-135A Boeing Co. jet cargo transports has rolled out of Boeing's Renton, Wash., plant. Developed from the KC-135 jet tanker, the first C-135 has been scheduled for MATS delivery this month; balance of order will be completed by mid-1962.

Since a propeller has gyroscopic characteristics it will tend to stay in its plane of rotation until it is displaced by some strong external force. When such a force or moment is applied, the propeller reacts in a direction 90 degrees to the force. For example, if the propeller is displaced upward the resistance of the structure applies a nosedown pitching moment causing the propeller disk to swing to the left due to precession. The yaw stiffness resists this motion causing precession downward, resisted by pitching stiffness which produces a precessional swing to the right. This, in turn, is resisted to cause an upward precession to complete the cycle. This effect is termed "whirl mode," and its direction of rotation is counter to that of the propeller.

Normally, whirl mode can operate only within the flexibility limits of the engine mounting structure and is quickly damped. If, however, the stiffness of the supporting system is reduced through improperly installed, failed, or damaged powerplant structure, mounts, or nacelle structure, the damping of whirl mode is reduced to a degree depending on the amount of stiffness reduction.

Structural weakness or damage does not change the conditions under which whirl mode may be initiated, but in three ways it makes the phenomenon a potential danger:

• **The greater flexibility** of a weakened system can allow whirl mode more freedom, hence it can become more violent. In an undamaged system the stiffness increases with increasing deflections but this is not necessarily true if the structure is damaged.

• **In a weakened installation,** the increasing violence of whirl mode can further damage the supporting structure, in turn leading progressively to more violence and even further damage.

• **As the structural system** is damaged, reducing the spring-constant, the amplitude of whirl mode increases and the frequency decreases from its natural value to lower values which, in the case of the Electra, approach the wing fundamental frequencies.

The natural frequency of whirl mode in an undamaged installation is approximately five cycles per second. The wing torsional frequency is about 3.5, and wing bending about two cycles per second, with some slight variation with fuel loading.

As whirl mode progresses in an overly flexible or damaged powerplant installation, its frequency can reduce from 5 to 3 cps. where it will drive the wing in 3 cps. torsional and bending oscillations. The wing oscillations will re-enforce and perpetuate the whirl mode. The three oscillations are then coupled at the same frequency of about 3 cps., thus becoming a form of induced flutter forced by a powerful harmonic oscillation. This phenomenon can exist, as demonstrated in wind tunnel tests and in analytical methods, at an airspeed far below that at which classical flutter can develop.

The design stiffness factor for an Electra powerplant installation is 15.9 x 10^6 inch pounds per radian (root-mean-square). The tests indicated that at this stiffness level whirl mode cannot force wing oscillation at an airspeed lower than 120 percent of the design dive speed of the aircraft. If, however, the stiffness is reduced, forced oscillations become more likely depending on amount of stiffness reduction and on equivalent airspeed. More specifically, the data show that if the stiffness is reduced to some value less than 8 x 10^6 inch pounds per radian, whirl mode could become a driving force on the wing in the cruising speed range. The test further showed that whirl mode of catastrophic proportions could develop, reduce its frequency, and couple with the wing in a period of from 20 to 40 seconds.

Certain causal possibilities can be eliminated from further discussion because of a complete lack of evidence or evidence to the contrary:

• **Collision with another aircraft.**

• **Structural failure due** to turbulence during this flight.

• **Structural failure from fatigue.**

• **Structural failure as a result** of boost and/or autopilot malfunction.

• **Sabotage.**

The shattered upper planking of the left inboard wing suggested a strong possibility of failure due to excessive positive loading. The horizontal tail or rear fuselage showed no such evidence; however, Lockheed testified that at 275 KIAS (last known airspeed) the wing and tail were about equally critical under positive loading. There was further testimony that above 275 knots the wing becomes the more critical of the two.

This leads to the premise that high-load wing failure (if it existed) occurred at an airspeed in the order of 275 knots (cruise) or higher. Such an overload failure, with boost, autopilot, and turbulence out of the picture, would have to develop from a pull

up maneuver brought on by collision avoidance or following loss of control. Since there was no known conflicting traffic, there is nothing to substantiate a theory of collision avoidance.

Loss of control has occurred in other instances because of a pilot's inattention to duty resulting in a dive or diving spiral. An analysis of a plot of the witness sightings, however, places the ball of fire at or about 15,000 feet. If, then, the ball of fire (wing-tank fuel ignition) was at or above 15,000 feet it would require a climb, intentional or not, prior to any loss of control of a type which would create excessive airspeed. (Note: It is extremely difficult to conceive of a recovery from an "unusual position" causing structural failure without first having excessive speed, particularly at the gross weight of this aircraft at the time of the accident.) This hypothesis cannot be maintained for it first presupposes a climb for which there would be no known purpose. If it be argued that the climb is unintentional, it becomes necessary to assume an extremely lengthy inattention. It must also be remembered that a scant four minutes prior to impact, or about three minutes prior to the witnessed noise, the flight reported 15,000 feet.

All this leads to a conclusion that, even with indications of high positive loading, there is a causal factor far more insidious than excesive air loads.

It thus becomes necessary to consider "whirl mode" which has been described, a phenomenon shown by wind tunnel tests and analysis to be a potential destructor. Some evidence of oscillatory motion was found in the left wing and No. 1 QEC/nacelle.

While this is not positive evidence of whirl mode, it is certainly compatible with the motions shown by tests to exist during the latter stage of excitation.

Another factor which is compatible with, but not proof of, whirl mode is the intense noise attested to by ground witnesses. Analyses by Lockheed and Board technical personnel have shown that during whirl mode the propeller tips approach sonic velocity without increase in rpm. or airspeed, and probably produce a noise in the order of 120 decibels. The witnesses heard such a noise at a time which would place the noise about 33 seconds prior to the fuel ignition. Analysis has shown that whirl mode, from inception to destruction, would last about 20 to 40 seconds. No avenue of investigation has revealed any other reason for the sound described and later identified by the witnesses.

As mentioned earlier, the left wing showed indications of high positive load. This is in complete contrast to the right wing failure at Cannelton. There is no way to establish with any degree of certainty this difference in wing failure patterns, but it is possible to rationalize a possibility. The first impulse of a pilot, when subjected to either severe vibration, a runaway propeller noise, or both, is to slow the aircraft down. Normal action would be to reduce power and to climb. Of the two, climbing is the more immediately effective, particularly in the Electra, which takes several minutes to reduce speed from 275 to 200 knots by power reduction. There is, then, the possibility that in the excitement and in his desire to slow down quickly, the pilot exerted back pressure sufficient to fail the wing earlier than if failure had resulted from oscillation alone. This is not to imply that the pilot applied a stick force capable of failing a structurally sound wing, but rather that his action dictated direction and time of failure.

There remains one point, the element of "prior damage," which cannot be satisfactorily explained. According to Lockheed, the stiffness factor of the QEC must be substantially reduced to produce an undamped whirl mode, or propeller precession. This suggests damaged or failed structure, engine mounts, or engine structural components. No such evidence was found. The No. 1 QEC and powerplant were examined minutely for fatique, with negative results. No other type of failure was discovered which could be definitely considered damage prior to whirl mode, QEC failure, and impact. There is serious doubt whether such a determination could be made with any degree of accuracy. For example, there were several pure tension and compression failures in the QEC structure which could have occurred prior to whirl mode or early in the precession. Furthermore, there is nothing in the aircraft's recent history, such as hard landings or turbulence, to indicate the possibility of prior damage, nor was there on the final flight, as far as can be determined, any incident leading to structural damage prior to the accident.

Conclusion

There was in this investigation no positive indication of the cause. For this reason, an attempt has been made in this report to eliminate certain possibilities by application of the available evidence to each of them. Once these possibilities have been disposed of, the only remaining causal factor for which there is some known basis is the condition of whirl mode. The probability that this accident was so caused is supported by the following:

- **So far as is known,** the aircraft was in straight and level flight and at a normal cruise speed with no serious mechanical problems.
- **Sound identified as a supersonic** or high speed propeller occurred 30 seconds prior to fuel ignition (wing failure).
- **There was structural damage** evidence compatible with oscillatory motion of the No. 1 QEC and the left wing.
- **First stage compressor blades** of No. 1 engine rubbed the air inlet housing supports.
- **The probable cause of a similar** accident of another Electra was due to whirl mode.

If prior damage is a requirement for the necessary reduction in stiffness, it must be assumed that the evidence of such damage was either obliterated in the crash or never existed in a discernible form.

The Board determines that the probable cause of this accident was structural failure of the left wing resulting from forces generated by undampened propeller whirl mode.

By the Civil Aeronautics Board.

ALAN S. BOYD, Chairman
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of this accident immediately after occurrence. An investigation was started at once in accordance with the provisions of the Federal Aviation Act of 1958. A public hearing was ordered by the Board and held in Buffalo, Texas, on October 21, 1959, and in Dallas, Texas, on March 9 and 10, 1960.

Braniff Airways, Inc., is an Oklahoma corporation with its principal office in Dallas, Texas. The carrier holds a certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Federal Aviation Agency. These certificates authorize the carrier to engage in air transportation of persons, cargo and mail within the United States, including the route involved.

Flight Personnel

Captain Wilson Elza Stone, age 47, was employed by Braniff Airways on April 22, 1939. He held a currently effective airman certificate with airline transport pilot rating number 24487. His other ratings included DC-3-4-6-7C, Convair 340-440, MEL, SEL and L-188. He had a total recorded flying time of 20,726 hours, of which 68:39 were in Lockheed Electra aircraft. He passed his last FAA physical examination September 21, 1959.

First Officer Dan Hollowell, age 39, was employed by the company on November 29, 1948. He held a currently effective airline transport rating certificate number 418671 with other ratings in DC-3 and Convair 340-440. He had a total recorded time of 11,316 hours of which 95:30 hours were in Electra aircraft. His last FAA physical was passed on June 11, 1959.

Second Officer Roland Longhill, age 29, was employed by the company July 16, 1956. He held a current airman certificate, flight engineer certificate number 1358795 and commercial pilot certificate number 1304814. He had a total recorded time of 3191:35 flying hours of which 83:03 were in Electra aircraft.

Hostess Alvilyn Harrison, age 25, was employed by the company December 29, 1953. She completed her Electra training June 4, 1959. Hostess Betty Rusch, age 24, was employed by the company on April 18, 1956, and completed her Electra training June 2, 1959. Hostess Leona Winkler, age 25, was employed by the company on March 21, 1958. She completed her Electra training June 4, 1959.

Extra crew member Wendell John Ide, age 35, was employed by the company July 9, 1951. His position was Technical Instructor to Engineer Specialists. He had mechanic's engine certificate number 1287530 issued November 30, 1955.

The Aircraft

At the time of departure from Houston N 9705C, a Lockheed Model L-188A, had had a total time of 132 hours and 33 minutes. Thus none of the periodic inspections, the first of which was to have been at 205 hours, had become due. All of the customary preflight service checks were performed during the ten days the aircraft was in use. All pilot complaints (squawks) had been signed off as corrected. The engines were Allison (a division of General Motors) model 501-D13 and the propellers were Aero Products (also a division of General Motors), model A6441FN-606.

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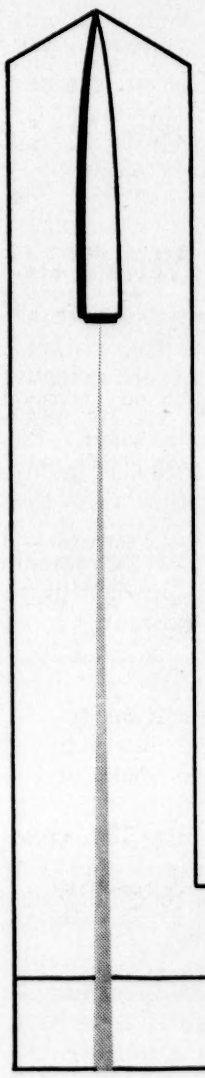

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LETTERS

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Due to the uncertainties surrounding the so-called manned orbital space flight made Apr. 12 by Russia, how can a world record be claimed solely on documentation furnished by Russia?

By past events and actions Russia has shown that it cannot be trusted to furnish the truth and nothing but the truth.

The first manned orbital space flight is too important an event to be recorded as a world record without having reliable and thorough proof.

Other nations allow the Federation Aeronautique Internationale to have representatives witness and verify aeronautical and space records.

If Russia feels she is deserving of having world record claims recorded then she should be willing to have F. A. I. personnel on hand to make certain the claims are worth more than the paper they are written on.

Until such time as reliable outsiders are able to verify Russian claims with adequate and indisputable proof I for one will not accept their so-called world records.

Let the records speak for truth and not for the sake of propaganda.

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Defense Concepts

McNamara's Band—Our recently acquired Secretary of Defense, McNamara, like his predecessors, has become a military expert by reason of appointment. His concept of defense is clouded by his economic background which pokes through the holes in his reasoning. The most atomic retaliation with the lowest cost delivery system may be good economics but is not the ideal state of preparedness. Economical mass suicide lacks mass appeal.

We need a nuclear potential but it may well fall into the category of gas warfare, which all combatants possess but none use for fear of retaliation.

If we are to have no Air Force to scramble and are to rely on missile countermeasures, then the billions of dollars spent on our early warning system are of questionable value as the reliability of the equipment and the interpretation of information received are such that there could exist a small margin of doubt which would delay action until we were in the midst of an atomic holocaust before we could, in clear conscience, push the button to destroy civilization.

McNamara states two objectives—(1) "A long-endurance aircraft," and (2) "A strategic system for economical delivery of conventional weapons." In regard to the first objective, why did the Administration kill the Aircraft Nuclear Propulsion project which was and is the obvious answer to this goal? As to the second objective, may we suggest a model B-17 bomber, as the missile requires the destructive area of a nuclear explosion to compensate for its lack of accuracy and a B-17 is as close to a B-52 as a B-52 is to a B-70 bomber in range and speed—I'm certain that it is proportionally much more economical.

If we are to negate all the advice and counsel of our military leaders who have made strategy and logistics of warfare their life work and let some well meaning novice by reason of his political position direct the whole nature of our defense effort, we will end up with the capability of the Cuban invasion force.

The B-70 program should have its name changed from the "Manned Missile" to the "Political Football." The Eisenhower Administration cut the program to a shell and incurred all of the cancellation costs brought about by the stoppage of well advanced development work by subcontractors all over the nation. Then came the second flight of the Wright brothers, the U-2, which proved that high flying aircraft could penetrate the Iron Curtain and the airplane was rediscovered by a congressional investigation committee, of which the present Vice President was a member.

The B-70 program was reactivated and now, with no scientific breakthrough other than political expediency, the program has again incurred cutbacks and cancellation costs. The most expensive thing about the B-70 is not the weapon system, but the political system.

If they must play politics, don't do it with our very existence on the face of this earth, because I don't believe we can all get into orbit.

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Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

'Fair Share of Market'

Much of our current news expounds efforts to obtain "Fair Share of the Market." Detroit manufacturers outline their tactics for obtaining their fair share of the market; national politicians propose to assure farmers of their fair share of the economy. Local politicians assure aircraft workers that if sent to Washington they will work towards obtaining a fair share of the aircraft market for home areas to assure continued employment. Legislation to guarantee small business a fair share of the market is currently quite vogue. High tariffs are urged to counteract foreign competition.

This effort may be good; however, it would appear that the "Fair Share of the Market" approach stifles rather than encourages progress. Its socialist overtones are subtly effective. The expression "Fair Share of the Market" tends to denote allocation by right of inheritance rather than by competitive superiority. This complacent tendency in our way of life, that we need exert no effort to deserve what we have, must give great comfort to world communism. This complacency has certainly allowed communism to expand its area of influence to the very doors of the United States.

The aircraft industry, as others, has been hoodwinked into an unconscious belief that socialistic measures are the answer to its economy problems. The popular attitude is that the diminishing funding for aircraft is allocated on a purely political basis. It matters only temporarily whether this attitude is justified since it (the attitude) further stifles competitive endeavor. Persistence in our current attitudes will completely eliminate any basis for allocation other than on a political or "employment disaster area" basis.

Self examination discloses areas in which most of us can improve our productivity. Without this individual improvement and especially the realization for the need of it, the advancement of our economy cannot be accomplished. Likewise, our various companies or corporations cannot effectively compete in the business world without this individual effort toward improvement.

Much emphasis has been placed on the advancement and capabilities of machines. However, machines alone are not the answer. The improved machine productivity must be coupled with improved individual productivity to accomplish leadership. This is exemplified by the increasing portion of the world market which is being lost to foreign competition. Our losses will continue as foreign machine capability is increased unless our individual productivity is increased to justify the differential in wages and living conditions.

Our vanishing world superiority is not a product of inheritance by virtue of being Americans, but rather the product of efficient labors of the past. Reduced efficiency has diminished our lead and will result in a complete loss of world leadership and prestige. Development costs for new products must be reduced in spite of increased labor costs—labor unions must insist on improved productivity to warrant improved wages.

An encouraging aspect of the current situation is that the first organization, in any field, to improve its attitude and productivity will have little trouble in capturing more than its "Fair Share of the Market" and members of the organization will be justly proud of their part in improving the United States and combating communism.

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Lost Dollars

With reference to your May 22, 1961, issue and the letter ("Space Economics") you printed from Stephen du Pont, Southbury, Conn., from one who is most understanding having just been through a similar existence, I would appreciate your printing my most sympathetic "Hear! Hear!"

If it will help the emphasis, let's try the "Hear! Hear!" in all caps.

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